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ABSTRACT

This literature review is one part of a research project, "The Comparison of Instructional Strategies," designed to investigate issues related to instructional procedures used with students having moderate and severe mental retardation and to develop and field test four modules/manuals using such procedures. The review examined the relevant (defined as instruction of this population in applied settings) literature from 1975 to 1986. Each chapter summarizes findings for one identified instructional strategy and includes an operational description of the procedure, methodological parameters, effectiveness and efficiency findings, and a bibliography of the reviewed research. The following instructional strategies are covered: error correction, antecedent prompt and test, antecedent prompt and fade, most to least prompting, system of least prompts, constant time delay, progressive time delay, naturalistic teaching strategies, and stimulus manipulation. A separate chapter addresses studies comparing two or more instructional strategies. A summary chapter notes commonalities across strategies, identifies issues for further research, and offers guidelines for selecting instructional strategies. (DB)

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Comparison of Instructional Strategies: A Literature Review

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A LITERATURE REVIEW

Mark Wolery

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David L. Gast

1986

Department of Special Education

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Introduction to Literature Review

Chapter 1

Mark Wolery, Patricia Munson Doyle, Melinda Jones Ault, and David L. Gast

Many issues in the education of students with moderate and severe handicapping conditions are interesting and demand research attention. Examples include service delivery models, assessment and placement procedures, control of inappropriate social behaviors, acceptance of the population in the community, family involvement, and personnel preparation and development. Another critical issue is instruction. The Comparison of Instructional Strategies (CIS) research project is designed to investigate issues related to instruction. CIS is a project funded by the Field Initiated Research Program of the Office of Special Education and Rehabilitation Services of the United States Department of Education to the Department of Special Education of the University of Kentucky. The CIS Project has three primary objectives:

1. To conduct a thorough review of the applied research literature that will result in a written product describing the instructional procedures that have been used in teaching students with moderate and severe retardation in applied settings.
2. To conduct and report on twelve investigations (four per year) using the selected instructional procedures (progressive time delay, constant time delay, mand-model procedure, system of least prompts) that result in recommendations concerning the relative effectiveness and efficiency (i.e., sessions, trials, and errors to criterion, and direct instruction time) of these procedures in teaching functional skills to preschool and elementary age students with moderate and severe retardation.
3. To develop and field test four modules/manuals that (a) describe the four instructional procedures (progressive time delay, constant time delay, mand-model procedure, system of least prompts), and (b) provide recommendations for the use of these procedures based on the results of the proposed investigations.

This product is an outcome of the first CIS objective. It was completed during the first year of Project CIS.

Purpose of Literature Review

This document describes what is currently known in the special education literature about instructional strategies used with students who have moderate and severe handicapping conditions. Researchers and teacher-trainers were targeted as the primary readers; practitioners were targeted to a lessor degree. The purpose of the document is twofold: (1) to assist researchers, teacher trainers, and practitioners in placing their own research and practices in the context of what is known about instructional strategies, and (2) to stimulate further research comparing the various procedures.

Description of the Review

The articles reviewed for this document addressed instructional strategies, primarily those used with subjects whose handicaps were moderate to severe handicaps. A strategy is defined as a replicable, systematized approach for providing instruction that addresses both antecedent and consequent events. The review focuses on instructional procedures, that is, how to teach. It does not, however, focus on manipulation of isolated instructional variables that are common across strategies. For example, the importance of manipulating reinforcement contingencies to facilitate attending during instruction is recognized, but this issue is not addressed because it is not unique to any given instructional strategy. Primary attention is given to acquisition of responses, although maintenance and generalization of responses are discussed. The review is limited, in large part, to studies that occurred since 1975, appeared in the professional literature, targeted students with moderate to severe handicaps, and addressed socially important behaviors.

Methods Used in Conducting the Review

The literature review progressed through six distinct stages. First, the limits of the review were defined. This step involved identifying professional journals that were likely to include reports of research related to teaching students with moderate and severe handicaps. These journals included:

American Journal of Mental Retardation,
Analysis and Intervention in Developmental Disabilities,
Applied Research in Mental Retardation,
Behavior Research of Severe Developmental Disabilities,
Education and Training of the Mentally Retarded,
Education and Treatment of Children,
Journal of Applied Behavior Analysis,
Journal of Autism and Developmental Disorders,
Journal of the Association for Persons with Severe Handicaps, and
Mental Retardation.

The parameters of the review also were specified and included: (a) all journal issues from 1975 until early 1986, (b) all articles addressing *instruction* of subjects with moderate or severe handicaps (age of the subjects and setting were not issues), and (c) only articles that were conducterd in applied settings or addressed applied behaviors/problems.

Second, each article from the identified literature was screened using a form developed by the project personnel (this for is available from the authors). Definitions of each item on the form are available from the authors. The completed forms were then categorized by instructional strategy. Although specific strategies (e.g., progressive time delay and the system of least prompts) were identified a priori, some categories of strategies were added, modified, or deleted as the articles were analyzed. These nine categories emerged from the literature: (a) error correction, (b) antecedent prompt and test, (c) antecedent prompt and fade, (d) most-to-least prompting, (e) system of least prompts, (f) constant time delay, (g) progressive time delay, (h) naturalistic teaching, and (i) stimulus modifications. An additional category included comparison studies where two or more of the above procedures were compared directly. Articles were placed into these categories based on the similarities of experimenter behavior across articles. Thus, categorization occurred on the basis of the described procedures rather than on the labels applied by authors. In many cases, experimenters used identical procedures but labeled them differently.

Third, each article was analyzed. The specific variables analyzed depended upon the strategy being reviewed; however, in all cases, the population, behaviors, antecedent events, consequent events, effectiveness, efficiency, maintenance, and generalization were addressed. The analysis for each category of the instructional strategies occurred separately.

Fourth, a description of the analyzed literature was written. Each strategy was described separately and was included as a separate chapter of this document. A final section was written that described summary statements from the review for researchers, teacher-trainers, and practitioners, and made suggestions about selecting instructional strategies.

Fifth, the written descriptions of each study were checked for reliability. A Research Associate who had not been the primary reviewer for a given section, reviewed a minimum of ten percent of the articles to ensure that the information in the written descriptions was correct. Interobserver agreement percentages for each category on the effectiveness tables were: gender = 100; age = 94; diagnosis = 92; setting = 94; behavior taught = 100; effectiveness = 100; efficiency = 83; generalization data = 100; maintenance data = 100; and design = 92. For strategy specific tables, the interobserver agreement percentages were as follows: name of behavior taught = 100; type of behavior taught = 100; procedural specifications = 100; consequences for correct responses = 94; and consequences for errors = 100.

Sixth, the written documents were reviewed by all project staff members. Other persons were also asked to review the product and to make comments for revisions. This product represents the summation of this process.

Organization of the Review

The review is organized into twelve chapters: an initial introductory chapter, a chapter for each of the identified instruction strategies, and a final chapter describing recommendations from the review and issues for selecting appropriate instructional strategies. For each chapter that describes an instructional strategy, an operational description of the procedure is presented followed by a review of the research pertaining to that strategy. The review of each strategy focuses on (a) the population and behaviors taught, (b) a description of the methodological parameters of the strategy, (c) the results from its use including effectiveness and efficiency data, and (d) summary statements about the strategy.

Other Important Instructional Issues

Since this review is limited to instructional strategies used in teaching persons with severe and moderate handicaps, many issues are not addressed. Some of these issues are mentioned here to acknowledge their importance and place the strategies within a broader instructional context. Wolery and Gast

(1984) suggest that all instructional endeavors implicitly or explicitly address at least four issues; these are discussed in the following paragraphs.

The content of instruction should be specified. Content refers to what is to be taught and is frequently known as the curriculum or scope and sequence. Teachers of students with moderate to severe handicaps commonly use two sources when identifying the content of the curriculum: normal development (e.g., Cohen & Gross, 1979a; 1979b) and the demands of current and immediate future environments (Brown et al., 1979). With the former, called the developmental (or "academic") model, the sequences of skill acquisition observed in typical children are transformed into instructional objectives for students with handicaps. The developmental model seeks to prepare students for a broad range of potential environments, and has been used extensively in early childhood special education programs and the development of early childhood assessment tools. With the latter approach, called the functional model, the activities and skills required for independent functioning in specific environments are identified and serve as the primary instructional objectives. The functional model seeks to prepare students for a limited number of environments. This model has been used extensively in secondary programs for students with moderate to severe handicaps. The emphasis placed on one model over the other is influenced by at least three factors. First, the student's age is considered; generally, the developmental (academic) model is used with younger students and the functional model is used with older students. Second, the severity of the student's handicap is considered; for students with mild handicaps the developmental model is recommended and for students with severe handicaps the functional model is advocated. Third, the imminence of transition into other educational or living situations is considered; the functional model is given more emphasis as a transition nears.

Specifying the content of instruction outlines the general skills to be learned, but may also influence the effectiveness and efficiency of instruction. Content that is viewed by learners as "interesting" and "worthwhile" may well be learned more readily than content viewed as "boring" and "useless." This issue needs research attention by curriculum developers for students with moderate and severe handicaps. Considerable agreement appears to exist on the general curriculum domains for students with moderate and severe handicaps (cf. Gaylord-Ross & Holvoet, 1985; Sailor & Guess, 1983; Snell, 1983); however, no uniformally accepted curriculum is apparent. Further, because of the heterogenity of learner characteristics and needs, no single universally accepted curriculum is likely to be developed.

Instruction should be matched to learners' needs and abilities. This activity includes initial and ongoing "matching." Initial matching involves some type of assessment of students' behavior and preferably the demands and supports of the environments in which they function. The initial assessment activities are determined, in part, by the model used for specifying the curriculum content. If the developmental (academic) model is used, then assessment activities will most likely include some developmental measures. On the other hand, if the functional model is used, then assessment activities will probably include ecological inventories (Snell, 1983) or activity catalogs (Wilcox & Bellamy, 1983). Neither approach is mutually exclusive and they can be used together.

Ongoing matching involves regular collection and analysis of data on learner performance (White & Haring, 1986). While relatively little research exists concerning teachers' collection and use of instructional data (cf. Farmer, 1985; Holvoet, O'Neil, Chazdon, Carr, & Warner, 1983), nearly all methods textbooks advocate this practice (e.g., Snell, 1983). Haring, Liberty, and White (1980) present initial data decision rules for analyzing data and making the relevant adjustments in the instructional program based on the patterns evident in the data series. Clearly, collection of performance data is simply a prerequisite step to ongoing matching of instruction to learners' needs and abilities; the data must be used to modify the instructional program. Data decision rules allow teachers to modify programs based on "hard" evidence rather than experience and assumption. A computer program called Aimstar incorporates those rules and can be used to facilitate teachers' analysis of data (Hasselbring & Hamlett, 1983, 1984). However, current trends in instruction will complicate the data collection issue. Currently authors are placing more emphasis on instruction using naturalistic procedures (Halle, Alpert, & Anderson, 1984) teaching behaviors within naturally occurring routines (cf. Neel, et al., 1983) and basing instruction in terms of ecologically variables (Rogers-Warren, 1984). Identification of behaviors to be measured, determination of measurement strategies, and application of rules for data analysis will become more demanding as these trends become more predominate.

Instruction involves some manipulation of environmental variables to facilitate learners' acquisition of targeted responses. While learning can occur separately from manipulation of the environment by others, teaching and instruction, by definition, imply that some person changes or structures the environment to influence the behavior of another (i.e., the student). Teaching can be conceptualized and implemented on a number of levels.

Examples include environmental arrangement and design (Bailey, Harms, & Clifford, 1983), material and instructional stimuli modification (Etzel & LeBlanc, 1979; Mercer, Mercer, & Bott, 1984), assistance provision through prompts (Billingsley & Romer, 1983; Wolery & Gast, 1984), and facilitation of students' attention and engagement with instructional activities (Paine, Radicchi, Rosellini, Deutchman, & Darch, 1983).

In this document, the literature concerning instructional strategies are described. Effective and efficient instruction must deal with appropriate use of instructional strategies, but must also include decisions related to the manipulation of many other variables. When screening articles for the literature review, many were found that did not address instructional strategies but focused on the manipulation of specific instructional variables. Although these variables are important, they are not reviewed here because several descriptions of effective teaching behaviors have recently appeared (cf. Bennett, 1986; Goode & Brophy, 1984; Paine et al., 1983; White, Wyne, Stuck, & Coop, 1983; also see Exceptional Children, April, 1986). However, examples of the decisions and practices that influence students' performance are described below.

Numerous teacher decisions are related to the environment in which instruction will occur. These include determining whether a classroom or a more natural setting will be used (Marchetti, Cecil, Groves, & Marchetti, 1984; Marchetti, McCartney, Drain, Hooper, & Dix, 1983), identifying ways to arrange the environment such as providing more varied materials (Horner, 1980), using dividers (Hooper & Reid, 1985), and manipulating variables such as lighting (Bailey, Wolery, & Sugai, in press) to enhance student engagement with instructional activities. Teachers must also determine whether a fixed or varied schedule of activities will be used (Frederiksen & Frederiksen, 1977) and whether particular times between activities will be employed (Nietupski, Clancy, Wehrmacher, & Parmer, 1985). Teachers should also analyze the use of different instructional arrangements such as group versus one-to-one instruction (Alberto, Jobes, Sizemore, & Doran, 1980; Favell, Favell, & McGimsey, 1978), and if groups are employed, they should determine whether unison or individual responding will be required (Sindelar, Bursuck, & Halle, 1986). Teachers also make decisions about instructional materials. They should analyze the stimulus properties of materials (Thvedt, Zane, & Walls, 1984) and employ those that (a) are similar to stimuli in the natural environment (Welch & Pear, 1980), (b) elicit the desired responses from students (Bambara, Spiegel-McGill, Shores, & Fox, 1984; Jones, Favell, Lattimore, & Risley, 1984), and (c) minimize the occurrence of over selective responding (Meisel, 1981; Schneider & Salzberg, 1982). When planning instruction, teachers should employ examples that are representative of the concepts being taught (Sprague & Horner, 1984), ensure that students can perform prerequisite skills, (Huguenin, 1985), and suppress competing responses (e.g., stereotypic behaviors) with certain students in certain conditions (Chock & Glahn, 1983). If the response being taught is a chained task, teachers must decide whether to use total task training, backward chaining, or forward chaining (cf. Spooner, Weber, & Spooner, 1983) and whether to use long or short task analyses (cf. Crist, Walls, & Haught, 1984).

During actual instruction, several variables also appear to influence students' performance. The following variables appear to facilitate acquisition:

(a) using distributed rather than massed or spaced trial presentation (Goetz, Gee, Sailor, 1985; Mulligan, Lucy, & Guess, 1982),

(b) presenting trials in natural contexts (Kayser, Billingsley, & Neel, 1986),

(c) providing information through a mode that matches the response to be performed (Barrera, Lobato-Barrera, & Sulzer-Azaroff, 1980; Remington & Clarke, 1983),

(d) presenting examples in concurrent rather than successive order (Fink & Brice-Gray, 1979; Waldo, Guess, & Flanagan, 1982) or initially presenting examples successively and then concurrently (Cuvo, Klevans, Borakove, Borakove, Van Landuyt, & Lutzker, 1980),

(e) interspersing previously learned behaviors with behaviors to be acquired (Rowan & Pear, 1985),

(f) requiring an attending response or delay interval after presentation and before responding (Dyer, Christian, & Luce, 1982), and

(g) presenting varied tasks (Dunlap & Koegel, 1980).

Teachers must also attend to how they provide assistance to students (Wacker, Steil, & Greenebaum, 1983) and match that assistance to the response being learned (Dowler, Walls, Haught, & Zawlocki, 1984). They must control the number and content of their verbalizations (Belch, 1978; Broden, Copeland, Beasley, & Hall, 1977) and the timing of their feedback (Hughes, Wolery, & Neel, 1983; Singh, Winton, & Singh, 1985). A rapid pace of instruction and specific response time limits appear to facilitate correct responding (Allyon, Garber, & Pisor, 1976; Koegel, Dunlap, & Dyer, 1980). Teachers should control and manipulate task irrelevant stimuli (Miyashite, 1985). Finally, the consistency with which instructional sessions are conducted may influence their outcomes (Carnine, 1981).

The consequences teachers provide after students respond correctly also require consideration. Although teacher attention, praise, and other commonly used stimuli may function as reinforcers for most students, some students may require selection of novel reinforcing stimuli (Wolery, Kirk, & Gast, 1985) or use of negative reinforcement (Mithaug, 1979). Teachers must also consider the density of reinforcement (Neef, Iwata, & Page, 1980) and whether the reinforcement is clearly related to the responses being acquired (Litt & Schreibman, 1981; Williams, Koegel, & Egel, 1981). Finally, teachers must carefully manipulate the reinforcement schedule (Koop, Martin, Yu, & Suthons, 1980; Mansdorf, 1977). Based on the preceding paragraphs, teachers clearly should consider a number of factors when planning and implementing instruction. Many of these manipulations can be made while using the instructional strategies described in this document.

Instruction should be designed to facilitate maintenance and generalization of learner responses to the natural environment. "Schools are publicly supported in the hope that more general uses will be made of what is learned in school. To some extent all schooling is aimed at a kind of transfer beyond the school" (Hilgard, 1956, p. 24). "Thus, transfer of learning is a cornerstone upon which education should ultimately rest" (Bigge, 1971, p. 244). However, a frequent and well recognized research finding with students who have moderate and severe handicaps is that learning occurs within the instructional situation, but is not maintained and does not generalize across settings, persons, behaviors, and variations in materials/conditions (cf. Stokes & Baer, 1977; Wehman, Abramson & Norman, 1977). Since Stokes and

Baer (1977) focused attention on this issue, considerable work has been initiated in developing and testing strategies for facilitating maintenance and generalization. Approaches for dealing with this problem can be grouped into at least two categories. The first approach is to teach in the natural environment and thereby side step the issue of generalization (cf. Gaylord-Ross & Holvoet, 1985; Kayser, et al., 1986; Sailor & Guess, 1983); however, this strategy is not totally nor consistently successful (White, Leber, & Phifer, 1985). Variations of this strategy are to match the behaviors being taught to responses that are needed in the natural environment, i.e, community-referenced instruction (Snell & Browder, 1986) and providing instruction that simulates natural conditions (Nietupski, Hamre-Nietupski, Clancy, & Veerhusen, 1986). The second approach to facilitating maintenance and generalization is to manipulate instructional variables. These manipulations take many forms, most of which were identified by Stokes and Baer (1977), including:

(a) targeting behaviors that will be needed frequently in the natural environment (Horner, Williams, & Knobbe, 1985);

(b) using materials similar to those found in the natural environment (Welch & Pear, 1980);

(c) carefully selecting and using exemplars during instruction (Pancsofar & Bates, 1985; Sprague & Horner, 1984);

(d) varying instruction variables such as using multiple trainers, settings, and intructional formats (Campbell & Stremel-Campbell, 1982; Dunlap, Koegel, & Koegel, 1984; Lowther & Martin, 1980);

(e) manipulating reinforcement contingencies by using or accessing natural reinforcers and contingencies (Stokes, Fowler, & Baer, 1978), delaying reinforcement (Fowler & Baer,1981), and decreasing the predictability of the contingencies (Baer, Williams, Osnes, & Stokes, 1984; Dunlap & Johnson, 1985);

(f) analyzing and manipulating competing behaviors (Billingsley & Neel, 1985; Matlock, Billingsley, & Thompson, 1985); and

(g) using self-management strategies (Fowler, 1984; Liberty & Michael, 1985).

Neither approach (teaching in the natural environment and manipulating instructional variables) guarantees that generalization will occur; thus, continual attention must be given to ensuring that maintenance and generalization are facilitated. Horner, Bellamy, and Colvin (1984) provide a conceptual framework for analyzing instances where generalization fails to occur.

The chapters that follow address specific instructional strategies. Less than a dozen repeatedly used instructional strategies emerged from the literature. These strategies were employed to teach a wide range of behaviors to a large number of subjects of different ages and functioning levels in a variety of settings. However, when teachers use these strategies they should specify the content of instruction, match instruction to learners' needs and abilities, manipulate other environmental or instructional variables, and faciliate the occurrence of maintenance and generalization.

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Error Correction

Chapter 2

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Error correction is a means of providing additional assistance or information to a student after an incorrect response has occurred. This is done in order to establish instructional control in the presence of the discriminative stimulus. This "corrective information communicates to the student that a response already performed is inappropriate or that a different action is needed" (Falvey, Brown, Lyon, Baumgart, & Schroeder, 1980, p. 109). Error correction differs from simple error consequation because additional assistance/information needed to perform a correct response is provided.

The type of assistance used in error correction may be a verbal instruction, model, gesture, visual cue, or any combination of these. The type of assistance selected is generally dependent upon the student, the student's response, and the behavior being trained. Bellamy, Horner, and Inman (1979) suggest that observation of student errors will help determine the type of correction cues. In addition they state, "the trainer should provide corrections with the least help possible that results in subsequent correct performance" (p. 109). This allows the student the opportunity to respond to correction cues most often approximating those found in the natural environment as well as eliminating the need for assistance as correct responding increases and instructional control is established.

The error correction trial sequence is shown in Figure 1 and consists of the trainer presenting the instructional discriminative stimulus and allowing the student the opportunity to respond independently. This is followed by the delivery of reinforcement for correct responding and some form of assistance

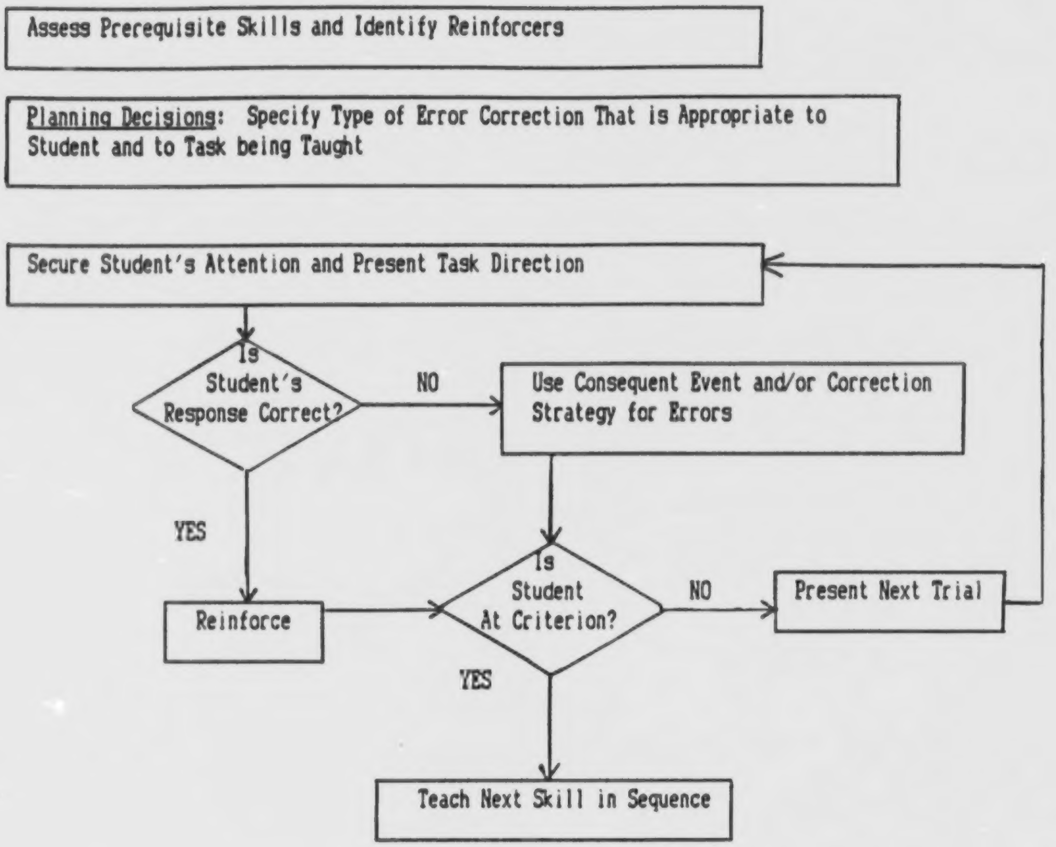
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Specify Type of Error Correction That is Appropriate to Student and to Task being Taught
Secure Student's Attention and Present Task Direction
Is Student's Response Correct?
NO
Use Consequent Event and/or Correction Strategy for Errors
YES
Reinforce
Is Student At Criterion?
NO
Present Next Trial
YES
Teach Next Skill in Sequence

Figure 2.1 Flow chart depicting the error correction strategy.

if an error occurred. Delivery of this assistance gives the student another opportunity to respond correctly, receive reinforcement, and practice the difficult response. Due to the amount of literature reviewed and experiments identified as error correction studies, this chapter describes only those articles meeting the operational definition of error correction. The studies reviewed here do not include those where only a differential consequence (e.g., verbal reprimand or timeout) was presented contingent upon errors; all studies described in this chapter providied additional information to the subjects contingent upon error. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in error correction investigations are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and consequences for correct and incorrect responses are shown in Table 2.

Table 1

Results from Investigations Using the Error Correction Strategy

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Ackerman & Shapiro (1984)	3M 2F	$\bar{X}$= 33	MoMR	CS	Vocat.; increase production	+	N/D	S= -	N/D	MB
Alberto et al. (1980)	16 N/D	6-9	MoMR	IN	Lang.: 1. prep. 2. colors 3. dress.	+V1V2>V3 1. V1=V2 2. V1=V2/V2>V1 3. V1>V2	N/D	N/D	N/D	AT
Variable 1 - Indiv.; Variable 2 - Group; Variable 3 - Control										
Albin (1977)	1M	7-11	PMR Aut	IN	Self care; feeding	+	N/D	S= +	M= +	MB
Altman & Krupsaw (1982)	1M	3	DD	SS	Attending; eye contact	+/- 14 sess.	N/D	T= +	N/D	MB
Anderson & Spradlin (1980)	1M	16	SMR	IN	Lang. express/ recept; label, match	+	N/D	T= +	D= +	MB
Bellamy et al. (1975)	1M 1F	22;26	SMR DD	IN	Vocat.; switch assembly	+	T,M	N/D	N/D	A-B-C-D
Braam & Poling (1983)										
Exp. I	1F	17	MH	PS	Sign categ.	+	S,M	T=+	D=+	MB
Exp. II	2F	17; 23	MH	PS	Intraverbals	+	S,E	N/D	D=+	MP
Bucher (1983)										
Exp. I	8M 3F	7-17	HI	IN	Recept. to prod. labeling	+	T,M	T=+	N/D	N/D
Exp.II	7M 5F	6-14	HI	IN		+/-	N/D	T=+/-	N/D	N/D

Table 1 continued.

Citation	Population Number / Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effective-ness	Efficiency	Generali-zation	Maintenance	Design
Bucher & Keller (1981)										
Exp. I	1M 3F	7-12	MiMR MoMR SMR	IN	Match/ express.	+/-	N/D	T=+/-	N/D	N/D
Exp. II	3M 2F	5-9	HI MiMR N	IN	Recept./ express.	+/-	N/D	T=+/-	N/D	N/D
Exp. III	10M 4M	3-7	HI N	IN	Recept./ express.	+/-	N/D	T=+/-	N/D	N/D
Campbell & Stremel-Campbell (1982)	2M	10; 12	MoMR	PS	Lang.; answer questions	+	S	T= +	D= +/-	MB
Carey & Bucher (1981)										
Exp. I	2M 2F	27-56	SMR PMR	IN	1. Correct eating 2. puzzle	1. +V1 -V2 2. -V3	N/D	N/D	N/D	A-B-A-
Variable 1- similar/ positive practice; Variable 2- dissimilar/positive practice										
Exp. II	2M 2F	27-56	SMR PMR	IN	Eating	+	N/D	N/D	N/D	A-B-A-
Variable 1- positive practice + restitution										
Carey & Bucher (1983)	4M 1F	10.11-13.7	MoMR SMR PMR	CS PS	Object placement	V1>V2	T,M= V1<V2 P/U	S= +	N/D	MB AT
Variable 1 - Short positive practice; Variable 2 - Long positive practice										

Table 1 continued.

Citation	Population Number / Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Desig
Carr et al. (1978)	4M	10-15	Aut	PS	Lang.; manual sign	+	T	T= +/-	N/D	MB
Carr & Kologinsky (1983)										
Exp. I	3M	9-14	Aut	PS	Lang.; mand signs	+	T	T= +/-	N/D	MB
Exp. II	3M	10-14	Aut	PS	General.; mand signs	+	N/D	P= +	N/D	MB
Certo et al. (1985)	1M	20.5	SMR	CS	Vocat., bus boy	+	S	N/D	D= +	MP
Close et al. (1978)	70 N/D	16-45	SMR	IN	Vocat.; axle-nut, axle-post assembly	+/- V1=V2 V3>V4	T= V3<V4	N/D	N/D	GR
Variable 1 - Specific; Variable 2 - Nonspecific; Variable 3 - VI + FP; Variable 4 - VI + G										
Dyer et al. (1982)	1M 2F	13-14	Aut	IN	Lang. concepts; pronoun, right, left	V1=+ v2=-	N/D	N/D	N/D	MB WTD
Variable 1 - Response delay; Variable 2 - No response delay										
Egel et al. (1984)	4M	6-8	Aut	PS	Lang. concepts; preposition	V1=+ V2=+	S= V2<V1	T= +/-m	N/D	AT MB
Variable 1 - Position Self; Variable 2 - Position Object										
Entrikin et al. (1977)	1M 2F	8.10-11.10	MoMR	PS	Academic; reading	+	N/D	N/D	N/D	MB

Table 1 continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Faw et al. (1981)										
Exper. 1 Training	3M 3F	16-22	PMR	IN	Lang.; manual signs	+	N/D	S,T= -	D= +	MB
Exper. 2 Generalization					Setting, stimulus general.	NA	N/D	S,T= +	N/D	MB
Foxx (1977)	2M 1F	6-8	SMR Aut	PS	Attending; eye contact	V2>V1	M	P,S= +/-m	N/D	ST CC ST MB
Variable 1 - Edibles, praise; Variable 2 - Edibles, praise, functional movement										
Foxx (1984)	2M 2F	6-8	SMR Aut	PS	Lang.; color, object, discrim.	+ V1V2	M= V2<V1	P,S= +m	W= +	AT
Variable 1 - Edibles, praise; Variable 2 - Edibles, praise, graduated guidance										
Frank et al. (1985)	1M 4F	11.3-13.6	MiMR	PS	Academic; micro. computer spelling	+	E,S	T= +m	D= +	MB VTD
Freeman et al. (1975)	1M	5	Aut	IN	Lang. express.; answer questions	+	S	N/D	N/D	A-B
Giangreco (1982)	1M	7	PMR	SS	Lang.; motor imitation	+	T	T= A +/-	M= +	N/D

Table 1 continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Goetz et al. (1985)	2M	12; 14	SMR	PS	Lang.; comm. books activities	V1=- V2=+	S	N/D	N/D	MB
Variable 1 - Trial presented traditional; Variable 2 - Interrupted training										
Gruber et al. (1979)	4M	18-26	PMR	IN	Comm. living; indep. travel	+	S	P= + T= A+	W= +	MB
Handleman & Harris (1980)	3M	6-9	Aut	SS CS	Lang.; answer questions	+	T	S= +	N/D	MB
Hanley-Maxwell et al. (1982)	6 N/D	10.5-14.8	MoMR	PS	Academic; reading	+/- V3V1V2> V4V1V2 V1>V2	T	N/D	W= +/-	GR
Variable 1 - Direct instruction; Variable 2 - Incidental learning; Variable 3 - High group; Variable 4 - Low group										
Horner et al. (1985)	1M 2F	12-53	MoMR PMR	CS	Comm. living; street crossing	+V1	T,S	S= +	M= A+	MP
Variable 1 - General case; Variable 2 - Control										
Huguenin (1985)	4 N/D	N/D	SMR	N/D	Lang. recept.; i.d. cards	+	S	T= +/-	N/D	MB WTD
Hundert (1981)	1M	10	Aut. HI	IN	Lang.; manual sign	+ V1,V2	T,E= V1<V2	P,S,T= V2>V1	N/D	AT
Variable 1 - Single stimulus; Variable 2 - Multiple stimulus										

Table 1 continued.

Citation	Population Number / Gender	 Age/ Yrs.	 Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Keller & Bucher (1980)	4M 1F	5.11-10.4	BMR MiMR SMR	IN	Lang. express; i.d. pictures	+ V1,V2	S,T= V1=V2	T= V1>V2	A-B, B-A, A-B, B-A...	
Variable 1 - Receptol productive training; Variable 2 - Productive only										
Koegel et al. (1979)	8M 4F	4.2-15	Aut	N/D	Lang. recept.; i.d. pictures	+	N/D	N/D	N/D	N/D
Krantz et al. (1981) Exper. I	4M	7.8-13.1	Aut	SS	Lang. express.; multiple descriptors	+	N/D	P,S,T= +	M= +/-	MB
Lally (1981)	9M 7F	9-16	MiMR MoMR	PS	Academic; computer assisted reading	+	N/D	N/D	M= +	GR
Lehr (1985)	2M 2F	12.6-21	MH	PS	Lang.; i.d. stove, dryer	-V1 +V2	AM	N/D	N/D	MB
Variable 1 - 10 Trial training; Variable 2 - 30 Trial training										
Lowther & Martin (1980) Exper. I 2 Trainers/ 1 Setting	1M 5F	20-33	SMR	IN	Social; positive greeting	E1+	N/D	P,S= +m,A	M= +A	MB
Exper. II 1 Trainer/ 2 Settings	1M 5F	20-33	SMR	IN	Social; positive greeting	E2+	N/D	P,S= +m,A	M= +A	MB

Table 1 continued.

Citation	Population Number / Gender	 Age/ Yrs.	 Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Luiselli & Rice (1983)	1M	8	MH	SS	Social; postive toy play	+	N/D	N/D	N/D	A-B WTD
Matson et al. (1982)	1M 2F	10-12	BMR MiMR	IN	Academic; spelling fluency	V2>V1	N/D	N/D	N/D	MB AT
Variable 1 - Positive practive; Variable 2 - Positive practice + reinf.										
Mithaug & Liberty (1980)	1F	20	SMR	PS	Lang. recept; i.d. words	+ 7 words +A 3 words	S	T= +	N/D	MB
Murdock et al. (1977)	2F	8.11; 9.7	MoMR	PS	Lang. express; artic.	+	S	S,P= +m	N/D	MB
Neef et al. (1983)										
Exper. I	3M 3F	6-8	DD	PS	Compliance do/don't	+	S	T=+	N/D	MB
Exper. II	5M 5F	6-8	DD	PS	General.; setting/ teacher	NA	N/D	S,P= +	N/D	MB
Nelson et al. (1980)	13M 7F	$\bar{X}$ = 11.5-13.1	Aut	SS	Self-care; shoe lacing	+	T	T = +/-	N/D	GR
Nietupski et al. (1984)	3M 1F	7.5-10.3	MoMR	PS	Comm. living; vending machine	+	T	T= +m	W= +	MP
Orelove (1982)	12 N/D	19-38	MoMR SMR	IN	Acad.; sight reading	+/-	N/D	T= +/-	Probes +	GR

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Page, et al. (1976)	5M	16-25	MH	PS	Comm. living; street crossing	+	S,M	S= +/-m	V= +/-m	MB
Palyo et al. (1979)	2M 1F	3.8-5.7	DD	SS	Lang.; answer questions	+	S	P,S,T= +m	D,M= +m	MB
Partington et al. (1979)	1M 4F	4-14	MiMR N	PS	Academic; tell time	+	S	T= +m	+A	CC
Reid & Hurlbut (1977)										
Exper. I	3M 1F	31-34	MH	IN	Comm. board	+	S	N/D	N/D	MB
Exper. II	3M 1F	31-34	MH	IN	Id. training	+	N/D	P,S= +	V= +	MB
Richman et al. (1986)	4F	17-21	MoMR SMR PMR	SS	Self care; menstrual care	+	N/D +	T= +	V= +	MB
Romanczyk et al. (1975)										
Exper. I Error Corr.	2M 2F	5.3-7.1	DD	SS	Social; positive interaction, play	+	N/D	N/D	N/D	MB WTD
Exper. II Withdrawn Error Corr.	4 N/D	7.10-12.10	DD	SS	Social; positive interaction, play	+ E2>E1	N/D	N/D	N/D	MB WTD

Table 1 continued.

Citation	Population Number / Gender	 Age/ Yrs.	 Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Singh et al. (1985)	2M 2F	11-17	MoMR	PS	Academic; read in context	+ V1V2>V3 V2>V1	E= V2<V1,V3	N/D	N/D	AT
Variable 1 - Error corr., all errors; Variable 2 - Error corr. at end of sentence; Variable 3 - No consequences										
Sisson & Barrett (1984)	3M	4.8-8.1	MiMR MoMR	SS	Lang.; expressive comm.	+V2 -V1	S= V2<V1	N/D	N/D	AT MB MP
Variable 1 - Oral comm.; Variable 2 - Total comm.										
Smeenge et al. (1980)	3M	17-23	MiMR ED	PS	Academic; measurement skills	+	N/D	T= +/-	V= +	MB
Trace et al. (1971)	7M 7F	14-18	MiMR MoMR	IN	Acad.; coin equiv.	+ V1>V2	S,E,M	N/D	V,M= V1+ V2-	MB
Variable 1 - Experimental group; Variable 2 - Control group										
Waldo et al. (1982)	2M 1F	8-16	SMR	IN	Lang. recept.; nonsense labels	V2>V1	T= V1<V2	N/D	N/D	A-B
Variable 1 - Serial; Variable 2 - Concurrent										
Walls et al. (1979)	16M 16F	18-50	MiMR MoMR SMR	CS	Vocat.; assembly skills	+ V1, V2, V3, V4	M,E= V1,V3,V4<V2 positive trend V4<V1,V3	N/D	V= +m V1,V2,V3,V4	GR
Variable 1 - Tactile; Variable 2 - Auditory; Variable 3 - Visual; Variable 4 - all 3										

Table 2

Methods from Investigations Using the Error Correction Strategy

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Ackerman & Shapiro (1984)	5	MoMR	Vocat.; increase production	DS	Social praise, pats on back	VI, FP
Alberto et al. (1980)	16	MoMR	Lang.; 1. prep. 2. colors 3. dressing	DS Ch	Edibles, Social Praise	Repeat VI/SD FP=A, repeat VI
Albin (1977)	3	PMR Aut	Self care feeding	Ch	Social praise, Edible	VI,FP
Altman & Krupsaw (1982)	1	DD	Attending: eye contact	DS	Social praise, Edible, toy	FP, repeat trial
Anderson & Spradlin (1980)	1	SMR	Lang. express./ recept.; label, match	DS	Social praise, primary reinforcer,	VR,MO, repeat trial
CODES	See Appendix A		See Appendix A	Ch = chained DS = discrete	N/D = not defined	VR = verbal reprimand NR = no response VI = verbal instruction MO = model G = gesture PP = positive practice FP = full physical manipulation VP = visual prompt OC = overcorrection IVI= indirect verbal instruction GG = graduated guidance SD = discriminative stimulus

Table 2 continued.

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Bellamy et al. (1975)	2	SMR DD	Vocat.; switch assembly	Ch	Compliments, edibles, physical affection	VI, MO, FP Assistance based on trainer discretion
Braam & Poling (1983)						
Exp. I	1	MH	Lang.; sign categ.	DS	Descriptive verbal praise, tokens	10 - sec. timeout
Exp. II	2	MH	Intraverbals	DS	Descriptive verbal praise, tokens	Repeat trial with MO
Bucher (1983)						
Exp. I	11	HI	Lang.:recept. to prod. labeling	DS	Social praise, edibles	MO, rearrange materials repeat trial in both experiments
Exp. II	12	HI	Label		Social praise, edibles	
Bucher & Keller (1981)						
Exp. I	4	MiMR MoMR SMR	Match/ Express.	DS	Social praise, edibles in all experiments	MO, G rearrange materials repeat trial; in all experiments
Exp. II	5	HI MiMR N	Recept./ Express.	DS		
Exp. III	14	HI N	Recept./ Express.	DS		
Campbell & Stremel-Campbell (1982)	2	MoMR	Lang.; answer questions	DS	Descriptive praise, token	Expand MO, 2-sec. wait

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences	
					Correct Responses	Error Responses
Carey & Bucher (1981)						
Exp. I	4	SMR PMR	1. Correct eating 2. puzzle	DS DS	Social praise	1. Positive practice, restitution 2. positive practice
Exp. II	4	SMR PMR	3. eating	DS	Social praise	3. positive practice, restitution
Carey & Bucher (1983)	5	MoMR SMR	Object placement	DS	Verbal feedback	Positive practice, VI, FP, repeat SD
Variable 1 - short positive practice; Variable 2 - long positive practice						
Carr et al. (1978)	4	Aut	Lang.: manual sign	DS	Social praise, edible	VR, VI, FP
Carr & Kologinsky (1983)						
Exp. I	3	Aut	Lang.: signing mands	DS	Received manded item	MO, differential reinforcement
Exp. II	3	Aut	General mand signs		Received manded item	MO, differential reinforcement
Certo et al. (1985)	1	SMR	Vocat.: bus boy	Ch	Edible (drink)	VI, G, MO, FP Assistance based on trainer discretion

Table 2 continued.

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Close et al. (1978)	70	SMR	Vocat.; axle-nut, axle-post assembly	Ch	Social praise	V1-V6
Variable 1 - IVI, G; Variable 2 - VI,G; Variable 3 - VI, FP; , FP Variable 4 - IVI, FP; Variable 5 - VI, FP(5x); Variable 6 - IVI, FP(5x)						
Dyer et al. (1982)	3	Aut	Lang.; concepts, pronoun, right/ left	DS	Social praise, primary	VR, MO if 3 consecutive incorrects
Variable 1 - Response delay; Variable 2 - no response delay						
Egel et al. (1984)	4	Aut	Lang.; concepts, prepositions	DS	Descriptive verbal praise, toys, activities, praise only remedial	SD/VI, FP, repeat trial MO on remedial
Entrikin et al. (1977)	3	MoMR	Academic; reading	DS	Social praise	VR, MO, repeat trial
Faw et al. (1981)						
Exp. I training	6	PMR	Lang.; manual signs	DS	Social praise	1. Repeat SD, if still incorrect-
Exp. II generalization	6	PMR	Setting/ stimulus generalization			2. SD + MO/Staff 1 FP/Staff 2
Foxx (1977)	3	SMR Aut	Attending; eye contact	DS	Social praise, edibles	VR, functional movement training
Variable 1 - edibles, praise; Variable 2 - edibles, praise, functional movement						

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Foxx (1984)	4	SMR Aut	Lang.; color, object discrim.	DS	Social praise, edibles	VR, GG
Varibles 1 - edibles, praise; Variable 2 - edibles, praise, graduated guidance						
Frank et al. (1985)	5	MiMR	Academic; micro-computer spelling	Ch	Social praise	VI
Freeman et al. (1975)	1	Aut	Express. lang.; question answer	DS	Edibles	MO, VI
Giangreco (1982)	1	PMR	Lang.; motor imitation	DS	Social praise, received item used in task	MO, VI, PP, FP(5x) when necessary. Assistance based on trainer discretion
Goetz et al. (1985)	2	SMR	Lang.; commun. books activities	DS	Social praise	MO, FP Repeat trial after 20-40 min.; errors on repeat trial results in no more opportunities to respond in that session.
Gruber et al. (1979)	4	PMR	Comm. living; indep. travel	Ch	Social praise, edibles	VR, VI if still incorrect VI, FP

Table 2 continued.

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Handleman & Harris (1980)	3	Aut	Lang.; answer questions	DS	Verbal praise, edibles	VR, MO
Hanley-Maxwell et al. (1982)	6	MoMR	Academic; reading	DS	Descriptive social praise	VI (R+), G, VI(SD) if still incorrect, VI again
Horner et al. (1985)	3	MoMR PMR	Comm. living; street crossing	Ch	Coins and/or social praise	VR, VI repeat task
Hugenin (1985)	4	SMR	Lang. recept.; id. cards	DS	Social praise, edibles, token	VR, VI, MO
Hundert (1981)	1	Aut HI	Lang.; manual signs	DS	Social praise, drink	VR, MO; if still incorrect- FP
Keller & Bucher (1980)	5	BMR MiMR SMR	Lang. Express.; id. pictures	DS	N/D	VR, MO repeat SD
Koegel et al. (1979)	12	Aut	Lang. Recept.; id. pictures	DS	Social praise, edibles	VR, remove materials; if still incorrect- FP
Krantz et al. (1981) Exp. I	4	Aut	Lang. express.; multiple descriptors	DS	Social praise, token, or points	MO, repeat SD; if still incorrect- next trial

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Lally (1981)	16	MiMR MoMR	Academic; computer assisted reading	DS	Computer praised student, lights flashed	VR, IVI; if still incorrect present VP
Lehr (1985)	4	MH	Lang.; id. stove, dryer	DS	Social praise	MO, require correct imitation
Lowther & Martin (1980) Exp.I 2 trainers 1 setting Exp. II 1 trainer 2 settings	6	SMR	Social; positive greeting	DS	Social praise, edibles	MO
Luiselli & Rice (1983)	1	MH	Social; positive toy play	DS	Reinforcers available in free play	30 sec. positive practice, (VI, FP)
Matson et al. (1982)	3	BMR MiMR	Academic; spelling fluency	DS	Stars or stickers, and praise	VI, OC
Variable 1 - positive practice; Variable 2 - positive practice + reinforcement						
Mithaug & Liberty (1980)	1	SMR	Lang.; recept. id. words	DS	Social praise and trainer accepted selected card	VR, MO, incorrect card not accepted; require correct response
Murdock et al. (1977)	2	MoMR	Lang. express.; artic.	DS	Social praise and end of session reinforcers	MO

Table 2 continued.

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Neef et al. (1983)						
Exp. I	6	DD	Compliance Do/Don't	DS	Descriptive verbal praise, edibles, hugs, praise, popcorn	descriptive VI, remedial trial, FP
Exp. II	10	DD	Generalization setting/ teacher			FP, praise for correct
Nelson et al. (1980)	20	Aut	Self-care; shoe lacing	Ch	praise, edibles, toys; "break" for independent response	FP
Nietupski et al. (1984)	4	MoMR	Comm. living; vending machine	Ch	Allowed to continue through task steps	MO, require correct response
Orelove (1982)	12	MoMR SMR	Acad.; sight read	DS	Descriptive verbal praise	MO, require correct imitation
Page et al. (1976)	5	MH	Comm. living; street crossing	Ch	Descriptive verbal praise	Explicit VI repeat trial, if incorrect, MO entire task and repeat trial
Palyo et al. (1979)	3	DD	Lang.; question/ answer	DS	Social praise, edibles	VR, in-seat timeout, MO, require correct response
Partington et al. (1979)	5	MiMR N	Acad.; tell time	DS	Social praise, intermittent edible	VI, MO

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Reid & Hurlbut (1977)						
Exp. I	4	MH	Comm. board	DS	Descriptive verbal praise	VI, FP repeat trial
Exp. II	4	MH	Board Id. training		Descriptive verbal praise	VI, repeat trial until correct
Richman et al. (1986)	4	MoMR SMR PMR	Self care; menstrual care	Ch	Social praise and/or edible	VI, repeat trial
Romanczyk et al. (1975)						
Exp. I error correction	4	DD	Social; positive interaction, play	DS	Descriptive verbal praise	PP contingent on NR
Exp. II withdraw error correction	4	DD				Gradual reduction of PP
Singh et al. (1985)	4	MoMR	Acad.; read in context	DS	Edible	V1=VI all errors V2=VI at end of sentence V3=No correction
Variable 1 - Error Correction all errors; Variable 2 - Error correction at end of sentence; Variable 3 - No consequence						
Sisson & Barrett (1984)	3	MiMR MoMR	Lang. express.; communication	DS	Edible, praise	VI, FP, or both, assistance based on trainer discretion
Smeenge et al. (1980)	3	MiMR ED	Acad.; measurement skills	DS	Descriptive praise	VI, repeat trial
Trace et al. (1971)	14	MiMR MoMR	Acad.; coin equiv.	Ch	Descriptive praise, edibles	VI, MO, repeat trial require correct response

Table 2 continued.

Citation	Population Number	Diagnosis	Behavior Name	Type	Consequences Correct Responses	Error Responses
Waldo et al. (1982	3	SMR	Lang. recept.; nonsense labels	DS	N/D	VR, MO
Walls et al. (1979)	32	MiMR MoMR SMR	Vocat.; assembly skills	Ch	N/D	V1=FP V2=VI V3=MO V4=FP,VI,MO

Variable 1 - tactile; Variable 2 - Auditory; Variable 3 - Visual; Variable 4 - all 3

Population

Error correction has been implemented with a diverse population. The handicapping conditions ranged from persons with borderline/mild (e.g., Frank, Wacker, Berg, & McMahon, 1985; Matson, Esveldt-Dawson, & Kazdin, 1982; Partington, Sundberg, Iwata, & Mountjoy, 1979), moderate (e.g., Campbell & Stremel-Campbell, 1982; Hanley-Maxwell, Wilcox, & Heal, 1982; Murdock, Garcia, & Hardman, 1977), severe (e.g., Goetz, Gee, & Sailor, 1985; Mithaug & Liberty, 1980; Waldo, Guess, & Flanagan, 1982), and profound mental retardation (e.g., Albin, 1977; Giangreco, 1982; Gruber, Resser, & Reid, 1979). The population also included persons with autism (e.g., Koegel, Schreibman, Britten, & Lartinen, 1979) and multiple handicaps (e.g., Bucher, 1983; Luiselli & Rice, 1983; Page, Iwata, & Neef, 1976).

The chronological ages of the students included preschoolers, 3.0-5.0 years (e.g., Altman & Krupshaw, 1982; Carr & Kologinsky, 1983), and 70% of the studies used elementary-aged and adolescent students, 5.0-17.0 years (e.g., Dyer, Christian & Luce, 1982; Foxx, 1984; Singh, Winton, & Singh, 1985). Adults, those 18 years or older, also participated in the error correction studies (e.g., Bellamy, Peterson, & Close, 1975; Carey & Bucher, 1981; Orelove, 1982).

Behaviors

The behaviors selected for training varied across studies. Although error correction was used to teach both chained and discrete behaviors across domains, the majority (78%) involved discrete responses. A large percentage (49%), taught discrete receptive/expressive language or language concept skills. For example, Braam and Poling (1983) trained intraverbal responses to categories of home, school, and people. Egel, Shafer, and Neef, (1984) taught autistic students prepositional concepts, and Hundert (1981) taught a multiply handicapped student manual labeling of pictures. Other discrete skills trained using an error correction strategy included academic or pre-academic skills (e.g., Lally, 1981; Smeenge, Page, Iwata & Ivancic, 1980), social skills (e.g., Lowther & Martin, 1980; Romanczyk, Diament, Goran, Trunell, & Harris, 1975), and increasing attending or on task behaviors (e.g., Ackerman & Shapiro, 1984; Foxx, 1977).

As noted in Table 1, 22% of the experiments taught a diverse selection of chained behaviors. These chained behaviors across domains included (a) self-care skills including shoe lacing (Nelson, Gergenti, & Hollander, 1980) and independent menstrual care (Richman, Ponticas, Page, & Epps, 1986); (b) community living skills such as independent street crossing (Horner, Jones, & Williams, 1985; Page et al., 1976) and appropriate vending machine use (Nietupski, Clancy, & Christiansen, 1984); and (c) vocational skills such as complex task assembly (Bellamy et al., 1975; Close, Irvin, Prehm, & Taylor, 1978; Walls, Ellis, Zane, & Vanderpoel, 1979) and bus boy skills (Certo, Mezzullo, & Hunter, 1985). In addition, Frank et al. (1985) task analyzed and trained beginning microcomputer skills and Trace, Cuvo, and Criswell (1977) taught a 3-response chain, coin-equivalancy task.

Consequences

Correct Responses

Of the studies reviewed, few specify differential consequences for corrected and uncorrected responses. Egel et al. (1984) delivered descriptive verbal praise, edibles, toys, and activities for correct responses to the S^D and praise only for correct response during a remedial trial. Palyo et al. (1979) reinforced all correct responses with praise and edibles whether they occurred in the presence of the S^D or following the error correction procedure. The reinforcers chosen for correct responding were student specific but generally included descriptive verbal praise.

Incorrect Responses

The operational definition of error correction includes teacher delivery of assistance contingent upon incorrect responding. Falvey et al. (1980) identified different types of error correction strategies which were effective in establishing instructional control: (a) primed correction procedures, (b) modeled correction, (c) direct verbal correction, (d) indirect verbal correction, (e) gestural correction, and (f) pictorial correction procedures. Primed correction strategies refer to full or partial physical guidance used to obtain correct responses following students' errors. Primed assistance was used in 42% of the error correction experiments. This percentage includes the use of physical guidance in isolation; for example, Egel et al. (1984) provided a remedial trial including a restatement of the S^D and physical guidance of correct receptive identification of prepositions, and Nelson et al. (1980) delivered a minimal manual prompt contingent on students' errors in shoe lacing. However, the majority of the studies presented physical assistance in combination with other types of correction procedures. Carey and Bucher (1983) delivered verbal correction and physical guidance following incorrect responses; Faw, Reid, Schepis, Fitzgerald, and Welty (1981) modeled and physically guided a correct manual sign following an error by adults with profound mental retardation; and Neef, Shafer, Egel, Cataldo, and Parrish (1983) delivered descriptive verbal correction plus a remedial trial and physical guidance contingent upon students' errors in a compliance/instruction following experiment. As seen in Table 2, a physical manipulation was used as part of the error correction strategy across behaviors and domains. The specific physical manipulations were generally task specific. For example, a different type of physical manipulation was used for dressing than for a receptive identification task. Falvey et al. (1980) suggest that use of direct physical guidance may be "non-functional or even counterproductive" (p. 110) when used to teach certain behaviors.

The second type of error correction is a verbal or nonverbal model or direct demonstration of the desired response by the trainer. A model in isolation or in combination with another correction type occurred in 42% of the experiments. Model correction in isolation included delivery of an expanded model of the correct behavior, correct intraverbal question answering (Campbell & Stremel-Campbell, 1982), and providing the S^D and model of a correct language descriptor (Krantz, Zalenski, Hall, Fenske, & McClannahan, 1981). As seen in Table 2, many studies using the model presented it with another type of correction procedure. For example, Goetz et al. (1985) delivered a model and manually guided the correct response while training a communication book system, and Sisson and Barrett (1984) delivered a vocal model, manual model, or both in an expressive language study.

Falvey et al. (1980) defined a direct verbal correction as a verbal instruction occurring after an error and one which provides supplementary information explicitly describing a desired response. An indirect verbal correction is an "implicit statement" (p.117) not explicitly defining the correct response. Verbal corrections were delivered in 33% of the studies. Included in this percentage are those experiments where the verbal discriminative stimulus was repeated as a direct verbal correction procedure in combination with another correction type. For instance, Alberto, Jobes, Sizemore, and Doran (1980) repeated the S^D, verbal cue, and then guided the student through the correct response. Examples of indirect verbal instructions found in Table 2, include saying, "Try another way" in an assembly task (Close et al., 1978), "Say word" used to increase spelling fluency (Matson et al., 1982), and "Try again" in training computer-assisted sight reading (Lally, 1981). For the studies cited in Table 2, the majority of the verbal corrections were direct corrections. For example, Neef et al. (1983) delivered descriptive verbal correction when increasing instruction following; Reid and Hurlbut (1977) delivered direct verbal correction and manual guidance when training use of a communication board; Smeenge et al. (1980) presented a descriptive verbal correction following errors while training an academic skill; and Walls et al. (1979) provided descriptive verbal instructions to one group when training complex assembly skills.

Gestural error correction procedures have also been used, but rather infrequently (i.e., < 1%). Gestures have been used to to indicate a correct response (Certo et al., 1985), to identify errors (Close et al., 1978) or in combination with other correction procedures such as a verbal model of the correct response (Bucher & Keller, 1981).

No examples were found of the sixth correction type, pictures, described by Falvey et al. (1980). However, other types of error correction occured such as positive practice (e.g. Carey & Bucher, 1981, 1983; Luiselli & Rice, 1983; Matson et al., 1982). In addition, 21% of the error correction studies specified the use of other consequences for errors paired with the correction procedures. For example, a mild verbal reprimand followed by a correction procedure (e.g., Entrikin, York, & Brown, 1977; Handleman & Harris, 1980; Huguenin, 1985; Keller & Bucher, 1980). Braam and Poling (1983) provided a

10-sec. timeout procedure followed by presentation of the S^D and model of correct response. Palyo, Cooke, Schuler, and Apolloni (1979) presented a loud "No" and a limited in-seat timeout followed by presentation of a taped correct response.

As stated previously, the majority (53%) of studies used a combination of correction procedures contingent on students' errors. Occasionally, experimenters specified different correction options, and delivery of an option was based on trainer discretion (e.g. Bellamy, et al., 1975; Certo, et al., 1985).

Results

Effectiveness

All of the studies identified as error correction investigations reported effectiveness data. The majority (79%) of the studies taught the target behavior to criterion. The remaining studies either (a) demonstrated mixed results (e.g., reaching criterion for some students but not others, for example, Hanley-Maxwell et al. [1982] taught reading skills to six students and four met criterion but two only improved performance over baseline levels) or (b) the authors did not train to criterion (Lally [1981] conducted a four week training program for computer-assisted sight reading).

Although the majority of studies reported data demonstrating the effectiveness of error correction as an instructional strategy, 27% manipulated an instructional variable resulting in some comparative data. These variables included (a) environmental manipulations such as group versus individual training (Alberto, et al., 1980), 10-trial versus 30-trial presentation (Lehr, 1985), and varying the number of trainers and settings (Lowther & Martin, 1980); (b) stimulus variation, Hundert (1981) compared single stimulus versus multiple stimulus training of manual signs, and Sisson and Barrett (1984) compared results of oral versus total communication training; or (c) post response manipulations, Close et al. (1978) compared effectiveness and efficiency of six types of error correction procedures, Matson et al. (1982) compared positive practice versus postive practice plus reinforcement, and Walls et al. (1979) compared efficiency of four types of error correction prompts. In all of the parametric studies, error correction was the only strategy used.

Efficiency

Efficiency data such as total training time, number of sessions, number of trials to criterion, and total number of errors was reported in 56% of the studies. The most frequently reported efficiency data were the number of sessions to criterion (57%) followed by trials to criterion (38%). Some studies reported more than one efficiency measure. Braam and Poling (1983) reported sessions to criterion and total training time in their first experiment, and Trace et al. (1977) reported sessions, number of errors, and total training time. Anectdotal statements were also noted; for example, Foxx (1984) states that the length of each session decreased as negative reinforcement intervention occurred. The efficiency measures of each study reporting this data can be found in Table 1.

Summary

Based upon the literature reviewed, the following statements can be made.

- The population selected for training in the error correction studies demonstrated a wide range of variance in both chronological age and handicapping conditions.
- Error correction was used to teach a wide range of behaviors, however, the majority (78%) of studies reviewed taught discrete reponses.

- The type of error correction procedure selected was dependent upon the population and behavior being trained. The majority (53%) delivered a combination of correction types contingent on student errors.

- The majority of error correction studies reported that the procedure was effective in training a wide range of behaviors to students with a variety of handicaps.

- Efficiency data were reported inconsistently across studies. The majority reported total number of sessions and/or trials to criterion.

- The current literature cannot be used to establish the relative efficacy of one error correction procedure over others.

- Reinforcement for correct responses combined with error correction appears to be more effective that reinforcement alone or error correction alone.

- Comparisons of the effectiveness and efficiency of different types of error correction and error correction to other instructional strategies should be addressed in future research.

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Antecedent Prompt and Test

Chapter 3

Patricia Munson Doyle, Mark Wolery, Melinda Jones Ault, and David L. Gast

Antecedent prompt and test is a means of providing additional information about correct responses to students by presenting a prompt or cue with the discriminative stimulus. The simultaneous pairing of the S^D and the prompt increases the probability of the correct response occurring. Because the prompt is delivered prior to the opportunity to respond (e.g. Wolery & Gast, 1984), it must be removed in order to determine whether transfer to the natural S^D has occurred. The studies described in this section meet two criteria: (a) a single cue or combination of prompts that control the correct response is provided rather than a hierarchy of prompts and (b) test or probe trials without the prompt are provided rather than systematically fading the prompt as training progresses.

The information supplied by the antecedent prompt may be a verbal instruction, model, picture cue, or any combination of extra-stimulus prompts (e.g., Schreibman, 1975). Each type of cue may be further identified as either a stimulus or response prompt. Becker, Engelmann, and Thomas (1975) discriminated between stimulus prompts which provide the "essential aspects of the task stimuli" and response prompts which "control the specific form of the task response" (p. 25). In this chapter, the term antecedent prompt has been used to identify both stimulus and response prompts. The antecedent prompt and test procedure is similar to other response prompting procedures (e.g. antecedent prompt and fade, most-to-least, and graduated guidance) in that all of these strategies present the prompt prior to the response; however, the antecedent prompt and test is dissimilar because (a) a controlling prompt is presented and (b) the prompt is totally removed on test trials rather than being systematically faded.

The antecedent prompt and test trial sequence is shown in the flow chart in Figure 1, and consists of experimenters presenting the discriminative stimulus paired with the prompt. The student is then allowed to respond followed by the experimenters' delivery of consequences for correct or incorrect responding. At some other time, the discriminative stimulus is presented without the prompt. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using the antecedent prompt and test procedure are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

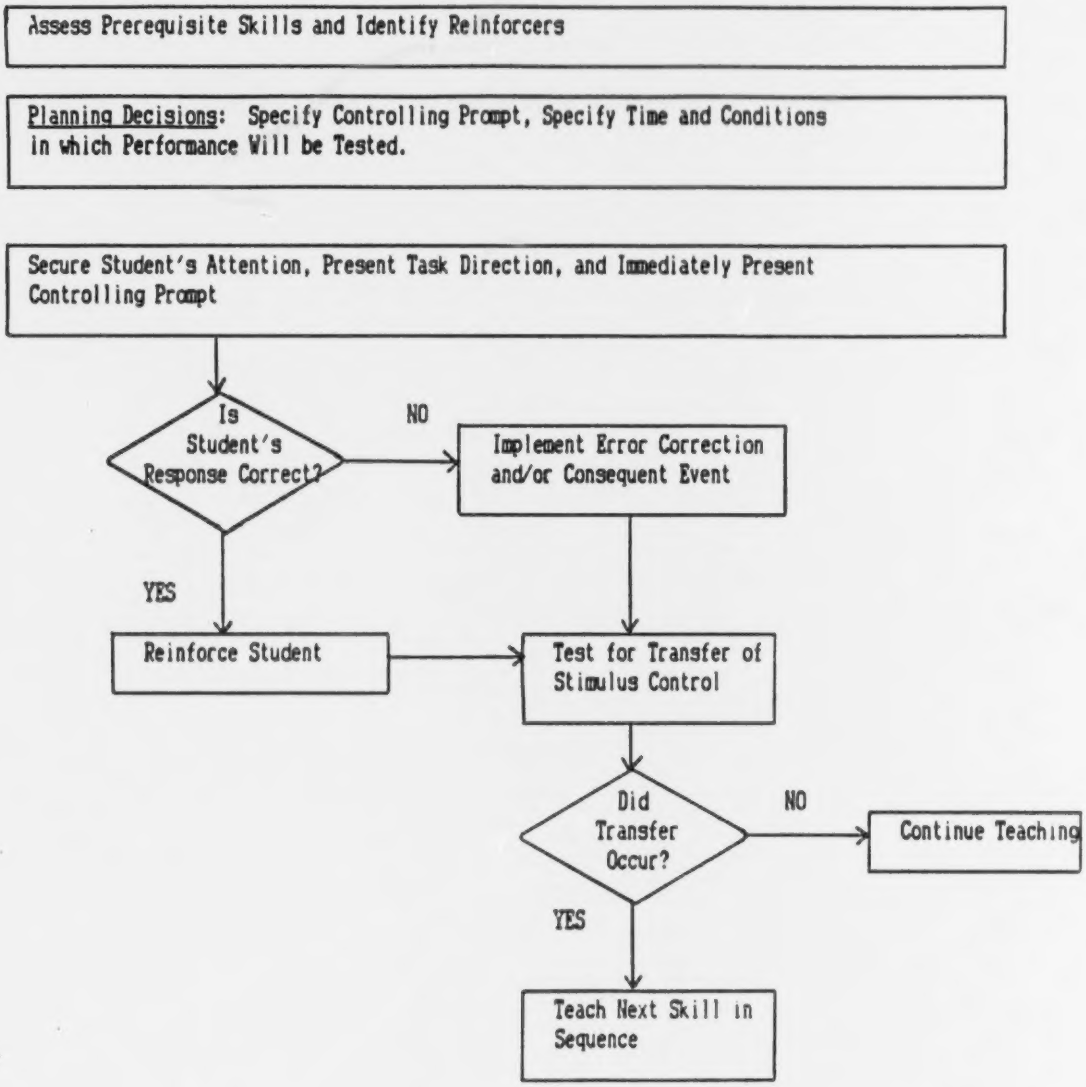
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Specify Controlling Prompt, Specify Time and Conditions in which Performance Will be Tested.
Secure Student's Attention, Present Task Direction, and Immediately Present Controlling Prompt
Is Student's Response Correct?
NO
Implement Error Correction and/or Consequent Event
YES
Reinforce Student
Test for Transfer of Stimulus Control
Did Transfer Occur?
NO
Continue Teaching
YES
Teach Next Skill in Sequence

Figure 3.1 Flow chart depicting the antecedent prompt and test strategy.

Table 1

Results from Investigations Using the Antecedent Prompt and Test Strategy

Citation	Population Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Adkins & Matson (1980)	6F	$\bar{X}$= 31.6	MoMR SMR	IN	Leisure; craft skill	+	N/D	A/T= +	V= +	MB
Borakove & Cuvo (1976)	7M	$\bar{X}$= 15.36	MoMR	SS	Academic; count, sum, coins	+V1 +V2	T=V1<V2 S=V1<V2	A/T= +/-	A, V= +/-	GR MB
Variable 1 - Displacement; Variable 2 - Non-displacement										
Brady & Smouse (1978)	1M	6.4	Aut	SS	Recept. inst. following; objects	-V1 -V2 +V3	N/D	N/D	N/D	AT
Variable 1 - SD/VI; Variable 2 -SD/sign; Variable 3 - SD/VI, sign										
Cooke & Apolloni (1976)	1M 3F	$\bar{X}$= 8.6	LD	SS	Social; smile, share, contact	+	N/D	P,S= + A,T= +/-	V= +	MB
Crist et al. (1984)	8M 13F	$\bar{X}$= 33.6	MiMR MoMR SMR	CS	Vocat.; complex assembly skills	+ across V1 - V6	M= V1=V2=V3 V4,V5<V6 E = V4,V5<V6 V2,V3<V1	N/D	N/D	GR
Variable 1 - Short task analysis; Variable 2 -Medium task analysis; Variable 3- Long task analysis Variable 4 - MiMR; Variable 5 - MoMR; Variable 6 - SMR										
DeHaven (1981)	3 N/D	6-14	SMR	PS	Recept. Inst. following	+ across V1-V3	E= V1,V2<V3	Probes -/V1,V2 +/V3	N/D	AT
Variable 1 - Inst. + model; Variable 2 - Inst.+ model; Variable 3 - Inst. + model/withdrawn										

Table 1 continued.

Citation	Population Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Fink & Brice-Gray (1979)	4M 6F	$\bar{X}$= 54 mo.	MoMR SMR	SS	Lang.; sight words	+V1 +V2	T= V2<V1	N/D	Post test V2>V1	GR
Variable 1 - successive; Variable 2 - cumulative										
Gersten et al. (1982)	12M 14F	>18	SMR	CS	Lang.; diagonal line discrim.	+V1 +V2	T= V1<V2	T= +	N/D	N/D
Variable 1 - Dynamic ; Variable 2 - Static										
Gickling et al. (1981)	4M 5F 4M 5F	9.4-16.5 5.2-6.0	MR N	PS	Lang.; sight words	+/- 10 sessions only	N/D	N/D	Post test D,A= V1>V2 A V3=V4	GR
Variable 1 - High imagery; Variable 2 - Low imagery; Variable 3 - MR; Variable 4 - N										
Hardiman et al. (1975)	1F	4.6	DD	SS	Motor; play equip.	+ V1>V2	N/D	T,S= +	M= +/-	MB WTD
Variable 1- VI; Variable 2 - differential reinforcement										
Katz et al. (1977)	2M 2F	19-27	SMR	CS	Vocat.; outlet plate assembly	+	M	S,P= +	W= +/-	N/D
Koegel et al. (1981)	3N/D	4.11- 7.1	Aut	SS	Lang.: complex concepts	+V1 -V2	T= V1<V2	N/D	N/D	MB
Variable 1 - Specific orienting cues; Variable 2 - Nonspecific orienting cues										
Lowe & Cuvo (1976)	2M 2F	$\bar{X}$= 14.8	MiMR	N/D	Acad.; count, sum, coins	+	M S E	N/D	W= +/-	MB PP

Table 1 continued.

Citation	Population Number/ Gender	 Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Mansdorf (1977)	14M 31F	$\bar{X}$= 18.5	SMR	IN	Lang.; concepts	+V4=V5=V6 +V1>V2,V3	N/D	T=+	N/D	GR
Variable 1 - image/model; Variable 2 - verbal/model; Variable 3 - model; Variable 4 - Diff. reinf.; Variable 5 - Noncontingent reinf.; Variable 6 - No consequence										
McGee et al. (1984)	3M	13-15.5	Aut	PS	Lang.; assertive statements	+	N/D	S=+	M= +	MB
Nelson et al. (1976)	2M 2F	3.0-5.9	MR	SS	Express. lang.; imitate	+ V1=V2	T= V2<V1	T= +/-	N/D	A-B-A-C-A
Variable 1 - Method A; Variable 2 - Method B										
Olenick & Pear (1980)	2M 1F	4	SMR	IN	Recept. lang.; picture naming	+ V1/V3-V2/V4 > V1/V4-V2/V3	E	N/D	N/D	5 phase reversal
Variable 1 - FR; Variable 2 - CRF; Variable 3 - Prompt; Variable 4 - Probe										
Peterson et al. (1979)	1M 2F	N/D	SMR PMR	PS	Social; interaction	+	P	P,S= +	A= +	WTD
Radgowski et al. (1978)	1 N/D	5.1	DD	PS	Express. lang.; articulation	+	N/D	N/D	Post test +	PP
Rowan & Pear (1985)	1M 2F	7-11	MR	IN	Express. lang.; label, pict.	+ V1>V2	T= V1<V2	T= V1=V2	V= V1=V2	B-A-B
Variable 1 - Interspersal; Variable 2 - Concurrent										

Table 1 continued.

Citation	Population Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Sarber et al. (1983)	1F	34	MiMR	CS	Comm. Living; menu, shop	+ menu + shop	N/D	S= +V2	W= +V1 +V2	PP MB
Variable 1 - Menu; Variable 2 - Shop										
Schutz et al. (1980)	2F	26	MoMR	CS	Vocat.; sweep, mop	+	N/D	S= +	M= +	MB
Shapiro & Sheridan (1985)	1F	30	MiMR	CS	Self-care; body parts, gyn. exam	+	N/D	A,S= +	A= +	MP
Sindelar et al. (1986)	5M 6F	6.9-11	LD MiMR	PS	Lang.; sight words	+ V1,V2	A,S= V2<V1	N/D	N/D	AT
Variable 1 - ordered; Variable 2 - unison										
Smeets & Kleinloog (1980)	3F	30.4-34.7	MoMR	CS	Comm. living; calculator	+	M,T,E	N/D	N/D	PP MB
Smith & Meyers (1979)	42M 18F	42.7-49.10	MoMR SMR PMR	IN	Comm. living; phone use	+= V1-V6 V2,V4>V1,V3 V1-V4>V5,V6	A,M = V1-V4<V5,V6	S= +	W,M= +/-	GR
Variable 1 - Indiv./MO, VI; Variable 2 - Group/MO, VI; Variable 3 - Indiv./MO; Variable 4 - Group/MO; Variable 5 - Control/ lecture; Variable 6 - Control/ practice										
Spangler & Marshall (1983)	14M	8-18	SMR PMR	IN	Social; play	+/-	N/D	N/D	N/D	A-B-A-WTD

Table 1 continued.

Citation	Population Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effective-ness	Efficiency	Generali-zation	Maintenance	Design
Wacker & Greenbaum (1984)	7 N/D	19-22	MoMR SMR	CS	Lang.; sort, color, shape, id.	+V1 +/-V2	S T=V1<V2	T= +/-V1,V2	N/D	MB
Variable 1 - Verbal; Variable 2 - Nonverbal										
Welch et al. (1985)	2M 4F	18-20	MoMR	PS CS	Comm. living; bus riding	+	M	S= +m	M= +	MP

Table 2

Methods from Investigations Using the Antecedent Prompt and Test Strategy

Citation	Population Number/Diagnosis		Behavior Name	Type	Type of Prompt and Testing Procedures/ Criteria	Consequences	
						Correct Responses	Error Responses
Adkins & Matson (1980)	6	MoMR SMR	Leisure; craft skill	Ch	1. Mo, 3 times 2. Independent test trial	N/D	VI, FP if needed
Borakove & Cuvo (1976)	14	MoMR	Academic; count, sum, coins	DS	1. MO 2. MO + imitate 3. independent test trial	praise	VR return to previous step
Brady & Smouse (1978)	1	Aut	Recept.; instruction following with objects	DS	1. V1, V2, V3 = MO, FP 2. A = test	V1, V3 = praise, edibles V2 - edibles smiles & touch	Diff. reinf.
Variable 1 - SD/VI; Variable 2 - SD/sign; Variable 3 - SD/VI, sign							
Cooke & Apolloni (1976)	4	LD	Social; smile, share, contact	DS	1. VI, MO beginning each day 2. observation rest of the school day	Descriptive verbal praise	VI, contingent on NR in observation
CODES	See Appendix A		See Appendix A	Ch= chained DS= discrete	VI= verbal instruction IVI= indirect verbal instruction MO= model FP= full physical SD= discriminative stimulus	VR=variable ratio reinf. CRF=continuous reinf. FR=fixed ratio N/D=not defined	VR=verbal reprimand VI=verbal instruct. MO=model FP=full physical GG=grad. guidance pp=posit. practice G=gesture NR=no response R+=corr. R-=error

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Type of Prompt and Testing Procedures/ Criteria	Consequences Correct Responses	Error Responses
Crist et al. (1984)	21	MiMR MoMR SMR	Vocat.: complex assembly skills	Ch	1. MO each step 2. independent test trial on whole task	N/D	MO whole task
DeHaven (1981)	3	SMR	Recept. instruction following	DS	1. Phase I, 2 inst. VI, MO 2. Phase II, 2 inst. VI, MO 3. 1 inst. VI alone	praise, token, or edibles	VI FP
Fink & Brice-Gray (1979)	10	MoMR SMR	Lang.: sight words	DS	1. MO, G, VI/SD 2. posttest, VI/SD alone	appropriate to participant	VR, MO, G, SD
Gersten et al. (1982)	26	SMR	Lang.: diagonal line discrim.	DS	1. 6 demonstration trials: MO, G, VI/SD 2. Independent test/ training trials	praise	VR MO
Gickling et al. (1981)	9 9	MR N	Lang.: sight words	DS	1. MO 2. imitate 3. MO in sentence 4. imitate in sentence 5. independent test 6. review & posttest	N/D	N/D
Hardiman et al. (1975)	1	DD	Motor: play equip.		1. V1 or V2 in training 2. observation session	praise in reinforcement condition	PP VI
Variable 1 - VI/IVI; Variable 2 - VI/IVI and differ. reinf.							
Katz et al. (1977)	4	SMR	Vocat.: outlet plate assembly	Ch	1. MO 2. imitate 3. changed to workshop, with SD alone	edibles	Diff. reinf.

Table 2 continued.

Citation	Population		Behavior		Type of Prompt and Testing Procedures/ Criteria	Consequences	
	Number	Diagnosis	Name	Type		Correct Responses	Error Responses
Koegel et al. (1981)	3	Aut	Lang.; complex concepts	DS	1. V1 or V2 plus task 2. A = task alone	praise	FP MO
Variable 1 - specific orienting cue; Variable 2 - non specific orienting cue							
Lowe & Cuvo (1976)	4	MiMR	Acad: count, sum, coins	DS	1. MO 2. MO + imitate 3. independent test trial	N/D	FP
Mansdorf (1977)	45	SMR	Lang; Concepts	DS	1. V1, V2, or V3 2. Wait 10 sec 3. independent test trial	V4, V5, V6	V4,V5, V6
Variable 1 - model/image; Variable 2 - model/verbal; Variable 3 - model alone Variable 4 - Diff.reinf.; Variable 5 - noncontingent reinf.; Variable 6 - no consequence							
McGee et al. (1984)	3	Aut	Lang; assertive statements	DS	1. model; training setting 2. rehersal; training setting 3. observation; game setting	tokens, praise	diff. reinf.
Nelson et al. (1976)	4	MR	Express lang; imitate	DS	1. V1 or V2 2. independent test sessions; MO alone	Differential reinforcement	
Variable 1 - Method A: MO + touch childs face; Variable 2 - Method: MO + child touches therapist face and own face							
Olenick & Pear (1980)	3	SMR	Recept. lang; picture naming	DS	1. prompt trial - picture, MO,SD/ VI 2. probe trial - picture, SD/VI	V1, V2 R+ on prompt, go to probe; R+ on probe, go to next prompt trial	R- on prompt, repeat prompt; R- on probe, return to prompt trial
Variable 1 - Fixed Ratio; Variable 2 - continuous reinf.; Variable 3 - prompt trial; Variable 4 - probe trial							

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Type of Prompt and Testing Procedures/ Criteria	Consequences	
						Correct Responses	Error Responses
Peterson et al. (1979)	3	SMR PMR	Social; inter-action	DS	1. direct VI 2. change setting for independent observation	praise	diff. reinf.
Radgowski et al. (1978)	1	DD	Express lang; artic-ulation	DS	1. formal; MO in group 2. formal prompt; MO with error correction 3. informal; MO, VI 4. posttest	praise	VI
Rowan & Pear (1985)	3	MR	Express language; label pict.	DS	1. prompt trial/picture, MO, SD/ VI 2. probe trial/picture, SD/VI	R+ on prompt, go to probe; R+ on probe, go to next prompt trial	R- on prompt, repeat prompt; R- on probe, return to prompt trial
Sarber et al. (1983)	1	MiMR	Comm. living; menu, shopping	Ch	1. MO 2. rehersal 3. independent test trial	praise	MO
Schutz et al. (1980)	2	MoMR	Vocat.; sweep, mop	Ch	1. direct VI prior to beginning task 2. observation	no consequences	
Shapiro & Sheridan (1985)	1	MiMR	Self-care; body parts, gyn. exam	DS	1. VI 2. imitate 3. MO (exam) 4. Rehersal: FP 5. Independent test trial	praise	VI, reinstruct
Sindelar et al. (1986)	11	LD MiMR	Lang; sight words	DS	1. MO, SD/VI; imitate 2. 3 independent test trials	N/D	VR, MO, repeat prompt trial

Table 2 continued.

Citation	Population Number/	Diagnosis	Behavior Name	Type	Type of Prompt and Testing Procedures/ Criteria	Consequences Correct Responses	Error Responses
Smeets & Kleinloog (1980)	3	MoMR	Comm living; calculator	DS	1. IVI 2. posttest 3. Exp. 2 removed VI	praise	VR, VI or VI, MO
Smith & Meyers (1979)	60	MoMR SMR PMR	Comm. living; phone use	Ch	1. V1 - V6; 2 sessions 2. independent test sessions	N/D	N/D
Variable 1 - individual/ MO, VI; Variable 2 - group/ MO, VI; Variable 3 - individual/MO; Variable 4 - group/ MO; Variable 5 - control/lecture; Variable 6 - control/practice							
Spangler & Marshall (1983)	14	SMR PMR	Social; play	DS	1. VI, FP 2. Observation	N/D	VI, FP
Wacker & Greenbaum (1984)	7	MoMR SMR	Lang; sort, color, shape, id.	DS	1. Variable 1 or Variable 2 2. independent test trial	praise, attention	VI, FP if needed
Variable 1 - verbal MO; Variable 2 - nonverbal MO							
Welch et al. (1985)	6	MoMR	Comm. living; bus riding	Ch	1. picture, VI 2. total task MO 3. practice; independent test trials	N/D	VI, MO if needed

Behavior/Population

The antecedent prompt and test procedure has been used to teach a wide range of behaviors across domains. The majority (76%) of the studies taught discrete behaviors. Examples of those skills included expressive language skills (McGee, Krantz, & McClannahan, 1984; Nelson, Peoples, Hay, Johnson, & Hay 1976; Radgowski, Douglas, Allen, & LeBlanc, 1978), receptive language skills (Rowan & Pear, 1985), language/academic skills (Gersten, White, Falco, & Carnine, 1982; Gickling, Hargis, & Alexander, 1981; Koegel, Dunlap, Richman, & Dyer, 1981; Sindelar, Bursuck, & Halle, 1986), community living skills (Lowe & Cuvo, 1976; Welch, Nietupski, & Hamre-Nietupski, 1985), leisure/social skills (Peterson, Austin, & Lang, 1979; Spangler & Marshall, 1983), daily living/self care skills (Sarber, Halasz, Messmer, Bickett, & Lutzker 1983; Shapiro & Sheridan, 1985), vocational skills (Crist, Walls, & Haught, 1984; Katz, Goldberg, & Shurka, 1977; Schutz, Jostes, Rusch, & Lamson, 1979), and motor skills (Hardiman, Goetz, Reuter, & LeBlanc, 1975). The studies teaching chained behaviors included potholder making (Adkins & Matson, 1980), object assembly (Crist et al., 1984; Katz et al., 1977), menu planning and grocery shopping (Sarber, Halasz, Messmer, Bickett, & Lutzker, 1983), sweeping and mopping (Schutz, et al., 1979), appropriate telephone usage (Smith & Meyers, 1979), and independent bus riding (Welch, Nietupski, & Hamre-Nietupski, 1985).

The population chosen for intervention in the antecedent prompt and test studies exhibited a wide range of handicapping conditions including students with mild mental retardation (Sindelar et al., 1986) and extending to severe and profound retardation (Peterson, Austin, & Lang, 1979), autism (McGee et al., 1984), physical handicaps (Hardiman et al., 1975), and learning disabilities (Cooke & Apolloni, 1976).

Type of Prompts

The type of prompt used appeared to be dependent upon the population, task selected for training, and experimenter discretion. The majority (79%) of studies used a model alone or in combination with another prompt. For example, Brady and Smouse (1978) paired a model with a verbal direction and/or a sign with physical guidance; Gersten et al. (1982) used simple declarative statements and questions to present a model six times; Lowe and Cuvo (1976) modeled a correct coin counting response while requiring concurrent imitation nby the student. Examples of other prompts included direct and indirect verbal cues (e.g., Hardiman et al., 1975), physical/kinesthetic prompts (Nelson et al., 1976), and verbal instructions (Peterson et al., 1979). All of these prompts provided information to the student as to the precise form of the correct response.

Stimulus prompts, see Table 2, make the task easier for the student by providing information regarding the "essential characteristics" of the task stimuli (Becker et al., 1975). For example, Koegel et al. (1981), while training a variety of language concepts, compared the effectiveness of nonspecific or indirect verbal attending cues to a specific orienting cue when paired with the S^D. In addition, Smeets and Kleinloog (1980) delivered a variety of indirect verbal discriminative instructions prior to each task component.

Test for Stimulus Transfer

With the antecedent prompt and test procedure, transfer of stimulus control to the S^D is tested by providing trials without the prompt. These trials were conducted in a variety of ways across studies. The most frequently used format was the model-lead-test strategy which involves the experimenter demonstrating the correct response, allowing the student to practice (often with the experimenter present), and requiring the student to respond independently to the discriminative stimulus (Carnine & Silbert, 1979).

Olenick and Pear (1980) trained expressive identification of pictures and provided prompted trials consisting of a model of the picture name and an opportunity to respond followed by a probe or test trial without the model. When teaching counting and coin summation, Borakove and Cuvo (1976) and Lowe and Cuvo (1976) presented a model and required concurrent imitation by the student, and this was followed by an independent test trial (i.e., the model prompt was removed and the student was given the opportunity to respond).

Crist et al. (1984) delivered a model of an assembly task step and instructed the student to perform that step (e.g., "Now you do it."). Each training trial was followed by a test trial or opportunity to perform the whole task independently. When training students to assemble an electrical outlet, Katz et al. (1977) delivered a model of the behavior and told the student to "Do it." When students were presented with the task in another setting, the experimenters removed the model and recorded the number of completed tasks. Mansdorf (1977) began teaching matching concepts with the experimenter modeling the correct matching response followed by a 10-sec wait and presentation of a trial without the model. Sindelar et al. (1986) taught sight words by having the teacher model each word in the instructional set, requiring students to imitate, and then providing three test trials without the model.

Some studies did not remove the prompt during training sessions but tested for stimulus control in other situations. One procedure was observational recording following training. For example, Hardiman et al. (1975) delivered direct verbal primes in a free play session then observed and measured engagement with, and skill in using, playground equipment in a second session; Cooke and Apolloni (1976) delivered verbal instructions and models for appropriate social interactions followed by observations for those responses throughout the day; and McGee et al. (1984) modeled and required repeated practice trials of assertive statements in a training setting, and then observed and measured the frequency of assertive statements in a game playing setting. Another procedure involved implementing test sessions following training sessions. For example, Smith and Meyers (1979) conducted test trials following two training sessions in correct telephone usage; Gickling et al. (1981) trained sight word reading and then presented review trials, omitting the antecedent prompt in sessions following training. Radgowski et al. (1978) trained correct articulation of the "L" sound followed by a posttest; and Smeets and Kleinloog (1980) trained three students to use a pocket calculator, however, the antecedent verbal cues were not removed until experiment 2.

Some studies stated transfer occurred; however, their descriptions were not in sufficient detail to determine how it was assessed. For example, Brady and Smouse (1978) stated that once the initial S^D "evoked the correct response" the experimenter went on to a second behavior (p. 274). Koegel et al. (1981) reported anecedotally that "some of the children were observed to continue to respond successfully after the specific orienting cues were withdrawn" (p. 196). In addition, DeHaven (1981) in phase I trained receptive instruction following using a verbal prompt and model; in phase II, a model and verbal prompt for training one instruction and a verbal prompt alone for training the fourth instruction were used. The correct responses to instructions trained with different types of antecedent prompts were compared in generalization probes.

Consequences

Correct Responding

The majority of studies using the antecedent prompt and test procedure reported that praise was delivered contingent upon the occurrence of correct responding during both training and test trials (e.g., Gersten et al., 1982). The studies which tested for transfer in observational settings or in later test sessions generally provided reinforcement in the training sessions alone.

Incorrect Responses

The consequences for errors varied across studies and in some cases trainers differentiated between training and test trials. For example, Smeets and Kleinloog (1980) used a verbal error correction procedure plus demonstration of the correct response on training trials only. In other studies, such as Adkins and Matson (1980), descriptive verbal statements explaining student errors were given followed by physical guidance if the verbal correction was ineffective. This error correction procedure was used in training and test trials. However, only those correct responses occurring without error correction on the test trials counted towards criterion. Some studies reported that student errors in training produced a continuation of the training trials versus going to a test trial (e.g. Olenick & Pear, 1980; Rowan & Pear, 1985). As reported in Table 2, consequences for both correct and incorrect responding were dependent upon population, behavior taught, and trainer discretion.

Results

Effectiveness

All antecedent prompting studies reported that the procedure was either effective in training target behaviors to criterion (e.g., Borakove & Cuvo, 1976; Crist et al., 1984; DeHaven, 1981) or increased the frequency of student responding over baseline rates (e.g., McGee et al., 1984; Peterson et al., 1979).

Although these studies reported data demonstrating the effectiveness of antecedent prompting as an instructional strategy, 52% manipulated an additional variable resulting in some form of comparative data. These variables included (a) stimulus variation, e.g., Brady and Smouse (1978) compared sign S^D alone, verbal S^D alone, to sign/verbal S^D, Crist et al. (1984) compared the effectiveness and efficiency of training complex assembly skills using short, medium, or long task analysis, and Koegel et al. (1981) compared performance during presentation of specific versus nonspecific orienting cues; (b) post response manipulations, e.g., Olenick and Pear (1980) compared different schedules of reinforcement on prompt and probe trials; (c) types of antecedent prompts; and (d) environmental manipulation, e.g., Smith and Meyers (1979) compared posttest scores following training of six groups in individual or group instruction settings in addition to varying the type of prompts delivered to each group.

Efficiency

Some form of efficiency data were reported in 52% of the studies. This information included total training time (Crist et al., 1984; Lowe & Cuvo, 1976; Smeets & Kleinloog, 1980; Smith & Meyers, 1979; Welch et al., 1985), sessions to criterion (Lowe & Cuvo, 1976; Wacker & Greenbaum, 1984), number of errors (Crist et al., 1984; DeHaven, 1981; Lowe & Cuvo, 1976; Olenick & Pear, 1980; Smeets & Kleinloog, 1980), trials to criterion (Fink & Brice-Gray, 1979; Gersten et al., 1982; Koegel et al., 1981; Nelson et al., 1976; Rowan & Pear, 1985; Smeets & Kleinloog, 1980; Wacker & Greenbaum, 1984), and one study calculated the median number of teacher prompts per 5-minute training sessions (Peterson et al., 1979).

Summary

Based on the literature reviewed, the following statements can be made:

* Antecedent prompting has been used to teach a wide range of persons with handicapping conditions.

* This strategy has been used to train a variety of behaviors to criterion and to increase performance of others. Both chained and discrete tasks were taught; however, the majority of studies employed discrete responses.

* The type of prompts used was dependent upon population, behavior, and trainer discretion; however, in 79% of the studies, a model alone or in combination with other prompts was used as the antecedent prompt.

* The most frequently used test for transfer of stimulus control was the model-lead-test, or a pretest-train-posttest format.

* The consequences for correct and incorrect responding varied across the studies and was based upon population and target behaviors.

* No data were reported comparing antecedent prompting with other instructional strategies. However, a slight majority of studies reported efficiency data; trials to criterion was the most frequently cited measure.

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Antecedent Prompt and Fade

Chapter 4

Melinda Jones Ault, Mark Wolery, Patricia Munson Doyle, and David L. Gast

The antecedent prompt and fade procedure involves the presentation of a prompt presented with the discriminative stimulus. "A prompt is defined as a cue that is presented with the S^D and that serves to guarantee correct responding" (Koegel, Egel, & Dunlap, 1980, p. 289). As training progresses, the prompt is gradually faded out until the student responds to the S^D alone. This procedure has been reviewed and procedural descriptions have been described in Striefel and Owens (1980) and Wolery and Gast (1984).

The antecedent prompt and fade studies reviewed here are similar to the most-to-least procedure and the graduated guidance procedure in that prompts are initially presented at the most intrusive level and assistance is gradually decreased over trials or sessions. However, these studies differ from those procedures in that the prompts are faded without using the most-to-least or graduated guidance procedure. Studies are included here if they do not have a hierarchy of prompts, specify a criterion for moving to the next prompt level, or do not involve the immediate fading or application of assistance based on moment-to-moment responding of the student. It is possible that some systematic prompt fading was used in these studies, but in the published report the procedures were not specifically described.

The prompt and fade trial sequence is shown in Figure 1 and consists of the experimenter presenting the novel stimulus paired with a prompt which controls the correct response. The student then responds and the experimenter delivers consequences for correct or incorrect responding. A description of the subjects, settings, behaviors, results, and experimental designs that were

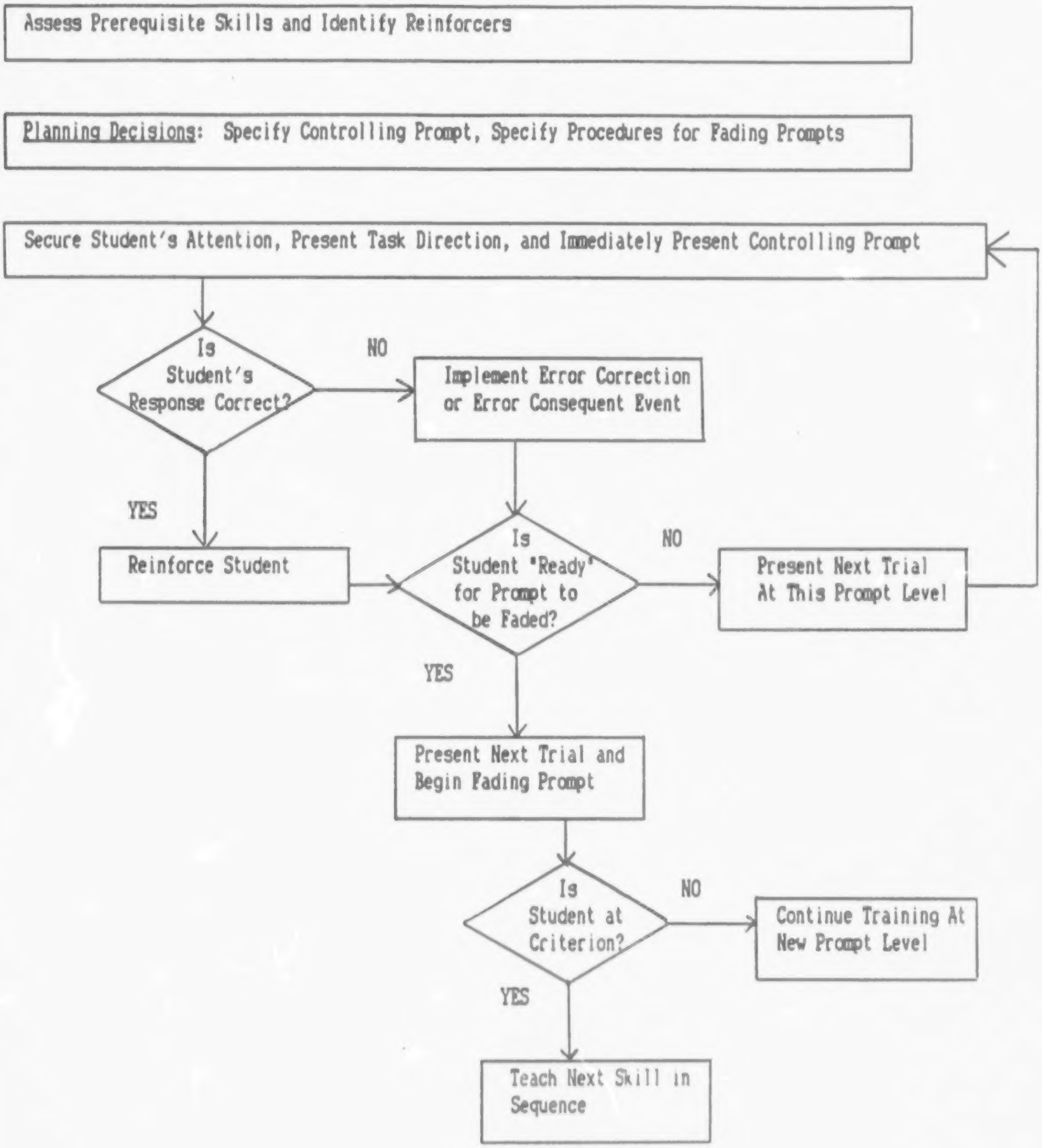
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Specify Controlling Prompt, Specify Procedures for Fading Prompts
Secure Student's Attention, Present Task Direction, and Immediately Present Controlling Prompt
Is Student's Response Correct?
NO
Implement Error Correction or Error Consequent Event
YES
Reinforce Student
Is Student "Ready" for Prompt to be Faded?
NO
Present Next Trial At This Prompt Level
YES
Present Next Trial and Begin Fading Prompt
Is Student at Criterion?
NO
Continue Training At New Prompt Level
YES
Teach Next Skill in Sequence

Figure 4.1 Flow chart depicting the antececent prompt and fade strategy.

involved in the investigations using the antecedent prompt and fade procedure are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

Table 1

Results from Investigations Using the Antecedent Prompt and Fade Strategy

Citation	Population			Setting	Behavior	Effective-ness	Efficiency	Generali-zation	Mainten-ance	Design
	Number/ Gender	Age/ yrs	Diag-nosis							
Barrera et al. (1980)	1M	4.6	Aut	CS	Express. id. of objects	V1+ V2+ V3+	T,S,M = V1>V2,V3	P,T=+	N/D	MB
Variable 1 - Total comm; Variable 2 - Sign alone; Variable 3 - Oral alone										
Clark & Sherman (1975)	2M 1F	15-17	MoMR VI	SS	Oral responding to questions	+	N/D	T=+	N/D	MB
	3M 1F	3.6-4.7	EC	CS						
Crouch et al. (1984)	2M 1F	23-33	MoMR	CS	Completing food service jobs	+	N/D	N/D	N/D	MB
Deckner & Blanton (1980)	15M 5F	5.25-16.92	SBD DD	SS	Pressing panel	+/-	N/D	N/D	N/D	Gr
Frank & Wacker (1986)	1M 3F	11.5-13.0	MiMR	PS	Make purchases	+	N/D	T=+	N/D	MB WTD
Knapczyk (1983)	1M	10	SMR	PS	Appropriate self-feeding	+	N/D	S,T=+	+M	WTD
Koegel & Rincover (1977)										
Exper. I	3M	7.5-11.0	Aut	IN	Motor imitation/ recept. id. of body parts	+	T	S,P=+/-	+/-N/D	N/D
Marchetti et al. (1983)	18N/D	19-59	MoMR	IN	Street crossing	V1- V2+	N/D	N/D	N/D	Gr
Variable 1 - classroom training; Variable 2 - community training										

Table 1 continued.

Citation	Population Number/ Gender	 Age/ yrs	 Diag- nosis	Setting	Behavior	Effective- ness	Efficiency	Generali- zation	Mainten- ance	Design
Murphy & Callias (1985)										
Exp. gr.	4M 6F	$\bar{X}$= 14	PMR	IN	Increase constructive play	-	N/D	N/D	-W	Gr
Control gr.	5M 5F	$\bar{X}$= 14.3	PMR	IN						
Oliver & Scott (1981)	6M 2F	19- 21	SMR	PS	Recept. id. of hard/heavy objects	+	T V1=V2	T V2<V1	N/D	Gr
Variable 1 - individual training; Variable 2 - group training										
O'Neill & Bellamy (1978)	1F	30	S/PMR	CS	Saw chain assembly	+	M	N/D	N/D	MB
Remington & Clark (1983)	1M 1F	10; 15	SMR Aut	SS	Manual signing	+	T,S V1=V2	T V2<V1	+/-W	AT MB
Variable 1 - sign alone; Variable 2 - total communication										
Rincover et al. (1979)	2M 2F	8- 10	Aut VI	SS	Toy play	+/-	N/D	N/D	+/-M	A-B
Rincover & Koegel (1975)	8M 2F	6.5- 13.5	Aut	IN	Motor imit Recept. id. of body parts/Right vs left	+	T	S,P+/-	N/D	WTD
Salisbury et al. (1978)	2M	13; 3	DD	IN; CS	Manual signing	+	N/D	S,T=+	N/D	N/D
Salvin et al. (1978)	1M	5	Aut	CS	Manual signing	+	N/D	T=+	+M	PP
Schreibman & Carr (1978)	1M 1F	7; 15	DD Sch	IN	Answering questions	+	T	T,P=+	+M	MB
Sternberg et al. (1985)	1M 2F	10- 21	PMR VI MH	PS	Co-active gross motor imitation	+	S	P=+	N/D	MB
VanBiervliet (1977)	6M	11.9- 21.8	DD	IN	Express./ recept. id. of manual signs	+	E S	T=+	N/D	N/D
Whitman et al. (1971)	1M 1F	4.5; 7	SMR	PS	Instruction following	+	N/D	T=+	N/D	WTD

Table 2

Methods from Investigations Using the Antecedent Prompt and Fade Strategy

Citation	Population Number/Diagnosis		Behavior Name	Type	Type of Prompt and Fading Procedures/ Criteria	Consequences	
						Correct Responses	Error Responses
Barrera et al. (1980)	1	Aut	Expres. id. of objects	DS	MO; fading N/D, A	praise	VR
Clark & Sherman (1975)	3	MoMR VI	Oral responding to questions	DS	MO, faded number of words modeled	praise	VR, MO then VR, timeout if needed
	4	EC					
Crouch et al. (1984)	3	MoMR	Completing food service jobs	DS	VI, faded VI and reinforcement	praise	N/D
Deckner & Blanton (1980)	20	SBD DD	Pressing panel	DS	FP, fading N/D, A	doorbell chimes, edibles	N/D
Frank & Wacker (1986)	4	MiMR	Make purchases	DS	VP, faded number of material prompts	N/D	N/D
Knapczyk (1983)	1	SMR	Appropriate self-feeding	Ch	FP + VI; faded FP; faded VI and verbal prompts	N/D	N/D
Koegel & Rincover (1977)	3	Aut	Motor imitation/ Recept. id. of body parts	DS	FP, faded intensity and delayed presentation of prompt	praise, edibles	none
Marchetti et al. (1983)	18	MoMR	Street crossing	Ch	VI, G, FP; fading N/D, A	praise, social reinforcement	N/D
CODES	See Appendix A		See Appendix A	Ch = chained DS = discrete	MO = model VI = verbal instruction FP = full physical manipulation G = gesture N/D = not defined A = anecdotal	VR = variable ratio reinforcement CRF = continuous reinforcement N/D = not defined	VR = verbal repri-mand MO = model FP = full physical N/D = not defined

Table 2 continued.

Citation	Population		Behavior		Type of Prompt and Fading Procedures/ Criteria	Consequences	
	Number/	Diagnosis	Name	Type		Correct Responses	Error Responses
Murphy & Callias (1985)	20	PMR	Increase constructive play	DS	FP, fading N/D	N/D	N/D
Oliver & Scott (1981)	8	SMR	Recept. id. of hard/heavy objects	DS	MO, faded prompts and added distractors/7 out of 8 correct move to next fading step	praise, tangible CRF	VR, repeat instruction; FP
O'Neill & Bellamy (1978)	1	S/PMR	Saw chain assembly	Ch	MO: 1 correct fade MO	verbal and social praise, edibles	FP or MO If no progress-VR and FP or MO
Remington & Clarke (1983)	2	SMR Aut	Manual Signing	DS	MO: fading N/D, A	unprompted-praise, edibles prompted-praise	FP faded over time
Rincover et al. (1979)	4	Aut VI	Toy play	DS	FP, faded over trials	edibles CRF	N/D
Rincover & Koegel (1975)	10	Aut	Motor imit./ recept. id. of body parts/ right vs. left	DS	FP, faded intensity and delayed presentation of prompt	praise, edibles	none
Salisbury et al. (1978)	2	DD	Manual signing	DS	MO: fading N/D, A or FP, fade degree of assistance	N/D	N/D
Salvin et al. (1978)	1	Aut	Manual signing	DS	FP: fading N/D	received stimulus	VR, placed hands at side, FP if repeated errors
Schreibman & Carr (1978)	2	DD Sch	Answering questions	DS	MO: fading N/D	N/D	N/D

Table 2 continued.

Citation	Population		Behavior		Type of Prompt and Fading Procedures/ Criteria	Consequences	
	Number/Diagnosis		Name	Type		Correct Responses	Error Responses
Sternberg et al. (1985)	3	PMR VI MH	Co-active gross motor imitation	DS	FP, fade locus of control	praise at first, then praise only for improved performance	N/D
VanBiervliet (1977)	6	DD	Express./recept. id. of manual signs	DS	MO; fading N/D, A	unprompted - token, praise CRF; edibles VR3 prompted - praise	FP faded
Whitman et al. (1971)	2	SMR	Instruction following	DS	FP, faded number of prompts given	Praise, edibles CRF	N/D

Behavior/Population

The antecedent prompt and fade procedure has been used to teach expressive language skills (Barrera, Lobato-Barrera, & Sulzer-Azaroff, 1980; Clark & Sherman, 1975; Remington & Clarke, 1983; Salisbury, Wambold, & Walter, 1978; Salvin, Routh, Foster, & Lovejoy, 1977; Schreibman & Carr, 1978; VanBiervliet, 1977), receptive language skills (Koegel & Rincover, 1977; Oliver & Scott, 1981; Rincover & Koegel, 1975; VanBiervliet, 1977; Whitman, Zakaras, & Chardos, 1971), imitation (Koegel & Rincover, 1977; Rincover & Koegel, 1975; Sternberg, McNerney, & Pegnatore, 1985), vocational skills (Crouch, Rusch, & Karlan, 1984; O'Neill & Bellamy, 1978), discrimination skills (Deckner & Blanton, 1980), daily living skills (Frank & Wacker, 1986; Marchetti, McCartney, Drain, Hooper, & Dix, 1983), self-help skills (Knapczyk, 1983), and play skills (Murphy & Callias, 1985; Rincover, Cook, Peoples, & Packard, 1979). The majority of behaviors taught with this procedure have been discrete tasks. However, three studies taught chained skills including appropriate self-feeding (Knapczyk, 1983), street crossing (Marchetti et al., 1983), and saw chain assembly (O'Neill & Bellamy, 1978). The population that participated in these studies included persons with mental retardation (ranging from mild to profound), autism, and multiple handicaps.

Fading of Prompts

A variety of prompts have been applied and then faded in these studies. They include: physical prompts, verbal models, physical models, verbal prompts, visual prompts, and a combination of two or more of the prompts listed above. The majority of studies initially applied a physical prompt and gradually faded the physical assistance provided as training progressed (Deckner & Blanton, 1980; Murphy & Callias, 1985; Rincover et al., 1979;

Salisbury et al., 1978; Salvin et al., 1977). For example, Rincover et al. (1979) taught four autistic children to play with toys. They stated "for each toy, a child was physically prompted through the topography of the correct response, and the physical guidance was gradually faded over trials" (p. 225). Rincover and Koegel (1975) and Koegel and Rincover (1977) also initially provided physical guidance but faded the assistance by delaying the delivery of the prompt and decreasing the intensity of the physical prompt. Sternberg et al. (1985) taught co-active gross motor imitation to profoundly handicapped students by fading physical assistance using first hand-over-hand guidance, followed by hand-over-elbow, and finally a touch prompt. Criterion levels for progressing from one of these prompts to the next were not specified. Whitman et al. (1971) faded physical guidance for following instructions by removing assistance first from the completion of the task and "it was progressively removed from other movements in the total response sequence in a reverse fashion" (p. 285). Physical assistance continued to be withdrawn until the student could perform the behavior in response to the verbal direction alone.

The next most frequently used prompt was a verbal model for teaching oral responses (Barrera et al., 1980; Clark & Sherman, 1975; Schreibman & Carr, 1978; VanBiervliet, 1977). Clark and Sherman (1975) taught three adolescents with mental retardation and four children from economically disadvantaged backgrounds to respond orally with complete sentences to three forms of questions. The experimenter stated the question, and then immediately modeled the entire answer. Over trials, the model was faded by decreasing the number of words modeled from the end of the sentence.

Physical models have also been used as prompts. In both the Oliver and Scott (1981) and VanBiervliet (1977) studies, receptive identification tasks were taught by initially presenting a model of pointing to the correct object and then gradually fading the model.

Verbal prompts were faded in the Crouch et al. (1984) investigation with what the authors called, "the verbal training procedure of the verbal correspondence training paradigm" (p. 273). Three adults with moderate handicaps were taught to reduce the time they needed to complete a vocational task. At the beginning of training, a coworker prompted the students by telling them a few minutes before they were to begin work the specific times they were to start and stop their jobs. These direct verbal prompts were then faded and thej subjects were required to state by themselves the times they would start and stop work. Finally, subjects were still required to state start adn stop times but received reinforcement only when they actually began and ended their jobs at the times they had started.

Frank and Wacker (1986) was the only study that faded visual or material prompts. Four mildly handicapped children were taught to make purchases using a number line, coin segments, and item segments. The authors state they used a 5-step procedure to fade each of these prompts, but specific procedures are not described.

The remaining studies used one or more of the prompts described above in their fading procedure (Knapczyk, 1983; Marchetti et al., 1983; O'Neill & Bellamy, 1978; Remington & Clarke, 1983). Knapczyk (1983) for example, taught a boy with severe multiple handicaps to self-feed appropriately by fading manual guidance first and then verbal prompts.

Movement Through Prompt Levels

The studies reviewed here did not specify exact procedures for progressing from one prompt level to another. Some of the studies did indicate that prompts were faded over trials or sessions (Clark & Sherman, 1975; Marchetti et al., 1983; Oliver & Scott, 1981; Rincover et al., 1979), where others stated that as the students' responding progressed, prompts were faded (Remington & Clarke, 1983; Salvin et al., 1977; Sternberg et al., 1985). Remaining studies simply stated that prompts were faded and did not elaborate further on the fading procedure.

Consequences

Correct Responses

Of the studies reviewed, three specify differential consequences for prompted and unprompted responding. Remington and Clarke (1983) provided praise plus food for correct responses following a model prompt and praise alone for correct responses that were physically prompted following the model. Sternberg et al. (1985) initially provided praise for both prompted and unprompted responses and later in training only provided praise for unprompted responses or responses which received prompts at a lower level of assistance. VanBiervliet (1977) provided praise only for prompted responses, whereas unprompted responses received praise plus a token on a CRF schedule of reinforcement and edibles on a VR3 schedule. Other investigations only specified consequences for correct responses and did not differentiate between prompted and unprompted responding.

Error Responses

Studies which specified consequences for incorrect responding utilized ignoring, verbal reprimand, putting through, time-out, and prompt and fade as error correction. Koegel and Rincover (1977) and Rincover and Koegel (1975) both stated that incorrect responses were ignored. Barrera et al. (1980) said "No" following an incorrect response and Salvin et al. (1977) said "No" and placed the student's hands at his/her side. Clark and Sherman (1975) and Oliver and Scott (1981) provided a verbal reprimand and then gave the correct response following an incorrect response. In addition, if the student still did not respond correctly, Clark and Sherman (1975) said, "No" and then provided a timeout.

Several studies used prompt and fade procedures as error correction (O'Neill & Bellamy, 1978; Remington & Clarke, 1983; Salvin et al., 1977; Van Biervliet, 1977). For example, in Remington and Clarke (1983) if a student did not respond correctly to a model prompt, physical prompts were provided and then faded. Salvin et al. (1977) stated that the prompt and fade procedure was reinstated if the student began making repeated errors.

Results

Effectiveness

The majority of the antecedent prompt and fade studies reported that the procedure was effective for teaching the targeted behaviors (e.g., Crouch et al., 1984; Koegel & Rincover, 1977; Remington & Clarke, 1983). Two studies reported mixed results of effectiveness in which some students acquired the behavior and some did not (Deckner & Blanton, 1980; Marchetti, 1983). Deckner and Blanton (1980) used an antecedent physical prompt and fade procedure to teach students to touch a panel containing 10 dots versus an empty panel. Sixteen of the 21 students did not acquire the behavior. Marchetti et al. (1983) compared a community group with a classroom group in teaching street crossing using an antecedent prompt and fade strategy. The procedure was effective for the community group but not for the classroom group.

Only one study reported that the prompt and fade procedure was not effective. Murphy and Callias (1985) compared an experimental group with a control group for increasing constructive play. The results indicated that seven out of 10 experimental students increased their constructive play, but no significant difference occurred between the two groups.

Efficiency

Nine of 20 studies reported some type of efficiency measure. These included trials to criterion, sessions to criterion, number of errors, days to criterion, minutes to criterion, rate of acquisition, and trial presentation rate across conditions (Barrera et al., 1980; Koegel & Rincover, 1977; Oliver & Scott, 1981; Remington & Clarke, 1983; Rincover & Koegel, 1975; Schreibman & Carr, 1978; Sternberg et al., 1985; VanBiervliet, 1977). The most frequently reported efficiency measure was trials to criterion.

Summary

Based on the literature reviewed, the following statements can be made:

- The antecedent prompt and fade procedure has been used to teach students with mild to to profound mental retardation and those with autism. Elementary- and secondary-aged students were the most frequently used in the studies.
- The majority of behaviors taught with this procedure were discrete tasks.
- Most of the studies employed physical prompts which were gradually faded.
- These studies did not state procedures for moving from one prompt level to the next prompt level.
- Most studies did not specify differential consequences for prompted and unprompted responses.
- The majority of studies reported that the procedure was effective in teaching the targeted behaviors.
- Few studies reported efficiency measures, but of those that did, trials to criterion was the most frequently cited.

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Most-to-Least Prompting

Chapter 5

Melinda Jones Ault, Mark Wolery, Patricia Munson Doyle, and David L. Gast

The most-to-least procedure or system of decreasing assistance involves systematically fading prompts from those which provide the most assistance necessary to emit a correct response to those which provide decreasing amounts of assistance. A hierarchy of prompts is used in the procedure. Initially, the most intrusive prompt is provided simultaneously with the novel stimulus until the student attains a specified criterion level. At this point, the next less intrusive prompt is provided. The students continue through the prompt levels until they respond to the novel stimulus without assistance. This procedure has been reviewed and procedural requirements have been described in Wolery and Gast (1984), Billingsley and Romer (1983), and Schoen (1986).

The most-to-least trial sequence is shown in Figure 1 and consists of the experimenter presenting the novel stimulus paired with a specified prompt level. This is followed by the student's opportunity to respond and the delivery of consequences for correct and incorrect responding. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using the most-to-least prompting procedure are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

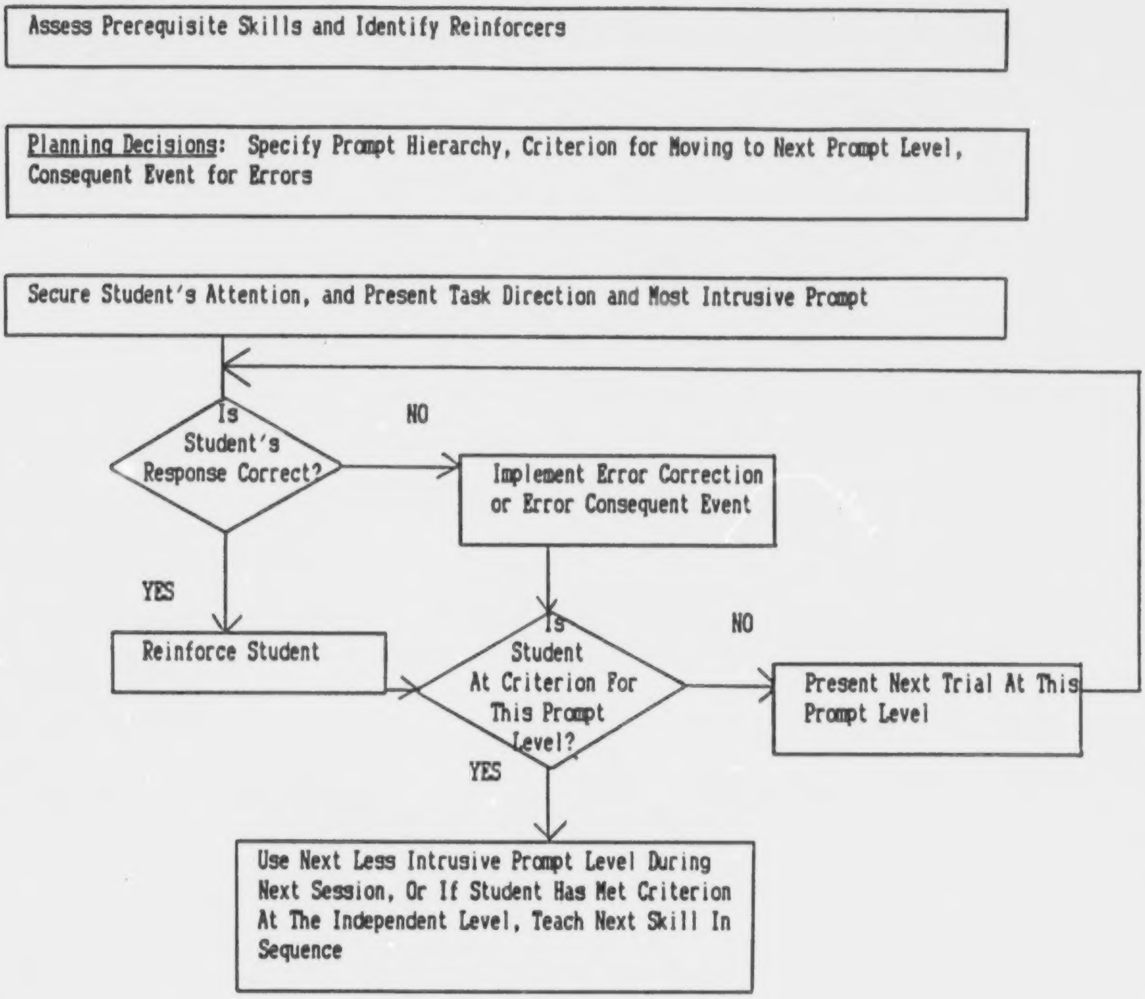
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Specify Prompt Hierarchy, Criterion for Moving to Next Prompt Level, Consequent Event for Errors
Secure Student's Attention, and Present Task Direction and Most Intrusive Prompt
Is Student's Response Correct?
NO
Implement Error Correction or Error Consequent Event
YES
Reinforce Student
Is Student At Criterion For This Prompt Level?
NO
Present Next Trial At This Prompt Level
YES
Use Next Less Intrusive Prompt Level During Next Session, Or If Student Has Met Criterion At The Independent Level, Teach Next Skill In Sequence

Figure 5.1 Flow chart depicting the most-to-least prompting strategy.

Table 1

Results from Investigations Using the Most-to-Least Prompting Strategy

Citation	Population Number/ Gender	Age/ Yrs	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Colozzi & Pollow (1984)	3M 2F	7- 12	MoMR SMR	PS	Walking to schoolroom	4 Subjects+ 1 Subject+/m	M P/U T	N/D	+W,Y	MB
Cuvo et al. (1981)	4M 1F	19- 21	MoMR MiMR	PS	Sorting garments	+	P/U M	N/D	+ND	MB
Cuvo et al. (1978)	3M 3F	13- 15	MoMR	PS	Cleaning restroom	+	P/U	S+	+W	MB
Duker & Michielson (1983)	1M 2F	8.8- 16.2	MoMR SMR	IN	Manual signing	+	S	P+ S+	N/D	MB
Duker & Morsink (1984) Exper.I	2F	22; 23	DD	IN	Manual signing	+	S	S+	+/-N/D	MB
Exper.II	2M	8; 13.3	Aut DD	IN	Manual signing	+	S	S+/-	+/-M	MB
Dunst et al. (1985)	6M	infants	PMR MH	SS	Fixated head turning	+	N/D	N/D	N/D	WTD
Hinerman et al. (1982)	1M	5	Aut	SS	Manual signing	+	S T	N/D	N/D	MB CC
Kayser et al. (1986)	5M 3F	6.11- 11.5	MoMR SMR PMR MiMR AuT	SS	Making snack	+/- V2>V1	M,P/U= 5 Subjects, V2<V1 M,P/U= 3 Subjects, V2=V1	S,P,T 4 Subjects, V2>V1 1 Subject, V1>V2 3 Subjects, V1=V2	N/D	MB
Variable 1 - Backward chaining, Multiple trials; Variable 2 - Total task, Single trial										
Luiselli et al. (1978)	1M	10	MoMR	PS	Answering questions	+/A	N/D	S+/- P+/-	+M	MB
Richmond & Lewallen (1983)	2F	15; 22	PMR	SS	Express. id. of letters/ animals	V1>V2	SV1<V2 TV1<V2	T+/-	+/-D	AT
Variable 1-Dual trainer; Variable 2 - Single trainer										
Wheeler et al. (1980)	6F 1M	13.3- 17.3	MoMR SMR	PS	Grocery shopping	+	M	S,P+	N/D	TT

Table 2

Methods from Investigations Using the Most-to-Least Prompting Strategy

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Criterion for Moving to Next Prompt Level	Consequences	
			Name	Type			Correct Responses	Error Responses
Colozzi & Pollow (1984)	5	MoMR SMR	Walking to schoolroom	DS	1. VI, FP 5/6 of way to room 2. VI, FP 4/6 3. VI, FP 3/6 4. VI, FP 2/6 5. VI, FP 1/6 6. I	1 correct, move to next level	praise	FP, VI
Cuvo et al. (1981)	5	MiMR MoMR	Sorting garments	Ch	1. VI, MO 2. VI, PMO 3. VI 4. I	90% correct on 1 trial, move to next level	praise FR3	VI then VI, GG if needed
Cuvo et al. (1978)	6	MoMR	Cleaning restroom	Ch	1. VI, MO 2. VI, GG 3. VI 4. I	1 correct, move to next level	praise, edibles VR	no re-inforcement
CODES	See Appendix A		See Appendix A	Ch = chained DS = discrete	I = independent IVI = indirect verbal instruction VI = verbal instruction VP = visual prompt G = gesture PMO = partial model MO = model GG = graduated guidance PPro = physical prompt PP = partial physical FP = full phys. manipulation SD = discrim. stimulus		FR = fixed ratio reinforcement	VI = verbal GG = graduated guidance VR = verb reprimand MO = model VP = visual prompt FP = full physical OC = overcorr. CE = cont exercise SD = disc stimulus N/D = not defined

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Prompt Hierarchy Sequence	Criterion for Moving to Next Prompt Level	Consequences Correct Responses	Error Responses
Duker & Michielson (1983)	3	MoMR SMR	Manual signing	DS	1. VI, VP, MO 2. VI, VP 3. VI	3 correct, move to next level	praise, edibles, or drink	VR, FP
Duker & Morsink (1984)								
Exper. I	2	DD	Manual signing	DS	1. SD, MO, VP 2. SD, VP 3. SD	3 correct, move to next level	Drink or manipulate object for 10 sec.	VR then FP, MO, or VP
Exper. II	2	Aut DD	Manual signing	DS	1. SD, MO 2. SD	Same as above	Same as above	VR then FP, MO, or VP
Dunst et al. (1985)	6	PMR MH	Fixated head turning	DS	1. FP 2. PP 3. I	5 min. at prompt level, move to next level	illumination of lights	none
Hinerman et al. (1982)	1	Aut	Manual signing	DS	1. SD, VI, MO 2. SD, VI 3. SD	80% correct for 60 trials, move to next level	social praise, edibles	OC then CE, OC on 2nd behavior
Kayser et al. (1986)	8	MiMR-PMR Aut	Making snack	Ch	1. FP 2. PP 3. PPro 4. G 5. I	3 correct, move to next level	edibles	N/D
Luiselli et al. (1978)	1	MoMR	Answering questions	DS	1. Full MO 2. MO first 1/2 of response 3. MO initial sound 4. I	10 correct, move to next level	descriptive praise FR1, token FR3	N/D
Richmond & Lewallen (1983)	2	PMR	Expres. id. of letters/animals	DS	MO, faded over 4 levels. Levels N/D	80% correct, move to next level	praise, edibles CRF	VR, repeat SD and prompt

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Prompt Hierarchy Sequence	Criterion for Moving to Next Prompt Level	Consequences Correct Responses	Error Responses
Wheeler et al. (1980)	7	MoMR SMR	Grocery shopping	DS	1. FP 2. MO 3. VI 4. IVI 5. G 6. VP	N/D	N/D	N/D

Behavior/Population

The most-to-least procedure has been used to teach daily living skills (Colozzi & Pollow, 1984; Cuvo, Jacobi, & Sipko, 1981; Kayser, Billingsley, & Neel, 1986; Wheeler, Ford, Nietupski, Loomis, & Brown, 1980), expressive language skills (Duker & Michielson, 1983; Duker & Morsink, 1984; Hinerman, Jenson, Walker, & Peterson, 1982; Luiselli, Colozzi, Donellon, Helfen, & Pemberton, 1978), cognitive skills (Richmond & Lewallen, 1983), fixated head turning (Dunst, Cushing, & Vance, 1985), and janitorial skills (Cuvo, Leaf, & Borakove, 1978) to learners with moderate, severe, and profound handicaps. Of these studies, seven used discrete tasks (Colozzi & Pollow, 1984; Duker & Michielson, 1983; Duker & Morsink, 1984; Dunst et al., 1985; Hinerman et al., 1982; Luiselli et al., 1978; Richmond & Lewallen, 1983) and four employed chained tasks (Cuvo et al., 1981; Cuvo et al., 1978; Kayser et al., 1986).

Uses of the Procedure

Most of the studies reviewed used the most-to-least procedure alone in teaching skills; however, some used it in conjunction with another strategy. In the Cuvo et al. (1981) and Cuvo et al. (1978) studies, the most-to-least procedure was used in combination with the system of least prompts. The most-to-least hierarchy was used for tasks that had been identified as difficult or for steps in the chain which had a high probability of error reponses. In Duker and Michielson (1983) and Duker and Morsink (1984), the system of least prompts was used to teach manual signing; the discriminative stimulus, however, was changed over trials in a most-to-least sequence.

Prompt Hierarchy

The prompt hierarchies used in these studies differ in the number of prompt levels employed in each hierarchy and in how the prompts were faded.

The hierarchies included an independent level of performance and the number of prompt levels ranged from three (Dunst et al., 1985; Hinerman et al., 1982) to six (Colozzi & Pollow, 1984; Wheeler et al., 1980). Some most-to-least studies employed a full physical prompt at the initial level of instruction and faded the amount of physical guidance given at each prompt level (Dunst et al., 1985; Kayser et al., 1986). Kayser et al. (1986), for example, taught eight students with moderate to profound handicaps to make a snack using the prompt levels of full physical assistance, partial physical assistance, physical prompt, gestural cue, and independent performance. Other studies initially provided a model and systematically faded it (Cuvo et al., 1981; Luiselli et al., 1978). In the Luiselli et al. (1978) study, answering questions was taught in the most-to-least sequence of the experimenter modeling the entire answer, modeling the first half of the answer, modeling the initial sound of the answer, and finally providing no model. Richmond and Lewallen (1983) stated that they faded a verbal prompt over four levels, however the exact prompt hierarchy was not specified.

Colozzi and Pollow (1984) faded both verbal prompts and teacher presence in teaching students with severe handicaps to walk from the entrance of their school to the classroom. Initial prompts consisted of the teacher stating the full verbal direction, (i.e. "Walk to the classroom with hands down") and assisting the student five-sixth's of the way to the classroom. Over prompt levels, the teacher's verbal direction was faded as well as the distance from which the teacher assisted the student.

The remainder of the prompt hierarchies used in the literature consisted of providing more than one prompt at the initial level, and then at each subsequent prompt level removing one of the prompts until the student responded independently (Cuvo et al., 1978; Duker & Michielson, 1983; Duker & Morsink, 1984; Hinerman et al., 1982). For example, Hinerman et al. (1982) used the prompt levels of (a) task direction, verbal prompt, and sign model; (b) task direction and verbal prompt; and (c) task direction alone to teach expressive manual signing to a student with autism.

Movement Through Prompt Levels

In order for students to move to the next level of prompting in the most-to-least hierarchy they were required to attain a specified criterion at the preceding prompt level. In the studies reviewed, students did not move to the next level of assistance until they attained a specified percentage of correct responses at a prompt level (Cuvo et al., 1981; Hinerman et al., 1982; Richmond & Lewallen, 1983), a specified number of consecutive correct responses (Colozzi & Pollow, 1984; Cuvo et al., 1985; Duker & Michielson, 1983; Duker & Morsink, 1984; Kayser et al., 1986; Luiselli et al., 1978), or received a level of prompting for a specified number of minutes (Dunst et al., 1985). In the Dunst study, infants with profound retardation and multiple handicaps were taught fixated head turning by the illumination of lights contingent upon a head turn. One of the students received prompts which were arranged in decreasing levels of assistance and included physically turning the child's head to midline, prompting the child to lift his head off the crib and initiate the turn, and providing contingent lights only. Progression from one prompt level to the next occurred when the experimenter provided each prompt for 5 minutes.

In addition to progressing to the next level of assistance following correct responses, students were required to return to a preceding prompt level following incorrect responses. If students made a specified number of incorrect responses (Colozzi & Pollow, 1984; Cuvo et al., 1978; Duker & Michielson, 1983; Duker & Morsink, 1984; Kayser et al., 1986; Luiselli et al., 1978) or did not attain a specified percentage of correct responses (Cuvo et al, 1981; Richmond & Lewallen, 1983), they were provided with the preceding prompt level. Although Wheeler et al. (1980) stated the use of "six kinds of cues and correction procedures, arranged from most to the least amount of assistance/intervention" (p. 109), the procedures were not defined and the criterion for moving from one prompt level to the next was not given.

Consequences

Correct Responses

Consequences for correct responses were provided regardless of the prompt level being used. These consequences included praise alone (Colozzi & Pollow, 1984; Cuvo et al., 1981), praise plus edibles (Cuvo et al., 1978; Duker & Michielson, 1983; Duker & Morsink, 1984; Hinerman et al., 1982), edibles alone (Kayser et al., 1986), praise plus tokens (Luiselli et al., 1978), and illumination of lights (Dunst et al., 1985). Presumably, these consequences were identified reinforcers for each student, although this was rarely documented.

Error Responses

Six of the studies specified consequences for incorrect responses. Cuvo et al. (1981) provided a verbal correction followed by verbal correction plus physical guidance if needed for an incorrect response. Hinerman et al. (1982) physically guided the student to form the correct manual sign 10 times after an error. Contingent exercise was added to this procedure when training was in progress on the second behavior. Duker and Michielson (1983), Duker and Morsink (1984), and Richmond and Lewallen (1983) provided a verbal reprimand plus additional prompts required to elicit a correct response. Colozzi and Pollow (1984) provided physical guidance and verbal directions following an incorrect response.

Results

Effectiveness

All of the studies reviewed reported that the most-to-least procedure was effective in teaching the targeted behavior. Both Cuvo et al. (1981) and Cuvo et al. (1978) stated that the students had rapid acquisition of sorting garments and steps in cleaning a restroom, respectively. In two studies, Luiselli et al. (1986) and Colozzi and Pollow (1984), a slight modification of one of the behaviors being taught and modification of the training steps respectively were required before the student reached criterion. Luiselli et al. (1986) shortened the required verbal response for one of the questions being taught. Following this modification, the student responded correctly. Colozzi and Pollow (1984) added additional training steps in order to raise one student's responding to criterion levels.

Efficiency

Efficiency measures were reported for nine of the eleven studies. Cuvo et al. (1981) reported the percentage of prompt level use and training time required to obtain criterion. Cuvo et al. (1978) reported the number of times prompt levels were used, and Hinerman et al. (1982) reported the efficiency measures of number of trials and days to criterion. The number of sessions to criterion measure was reported in Duker and Michielson (1983) and Duker and Morsink (1984). Colozzi and Pollow (1984) reported the number of days, average number of trials to criterion, and the amount of training per prompt level. In Dunst et al. (1985), one infant was provided with decreasing prompts and his performance was compared with infants who did not receive the prompts. The authors state that the infant who received prompts learned faster than those who did not receive prompts.

Kayser et al. (1986) compared a total task with a backward chaining method in teaching students with mild, moderate, and severe mental retardation and autism to make a snack. Both of the methods were taught using a most-to-least prompting procedure. Total task training and backward chaining were compared on number of changes in levels of assistance and instructional session time. Richmond and Lewallen (1983) compared a single trainer with a dual trainer using the most-to-least procedure and evaluated them on the number of training sessions, percentage of correct responses, mean rate of correct responding, and trials to criterion.

Summary

Based on the literature reviewed, the following statements can be made:

* The most-to-least procedure was used with students who have mild, moderate, severe, and profound mental retardation and autism.
* The procedure was used with students ranging in age from infants to adults, but most often with elementary- or secondary-aged students.
* Both chained and discrete tasks have been taught with this procedure.
* The most-to-least sequence has been used to manipulate the S^D while system of least prompts was used for training.
* The most-to-least procedure has been used in conjunction with system of least prompts to teach more difficult steps or tasks likely to have high error rates.
* The number of prompt levels used ranged from three to six. The majority of studies employed either three or four levels of prompts.
* Most studies moved through prompt hierarchies by fading a combination of prompts (e.g., fade both physical and model prompts).
* Students were required to reach a specific criterion at each prompt level before proceeding to the next level.
* Most studies reported some efficiency measure.

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System of Least Prompts

Chapter 6

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The focus of this chapter is on studies using an instructional strategy of less to more intrusive extra-stimulus prompts (Schreibman, 1974) in facilitate acquisition of new skills. The term system of least prompts (SLP) was used to refer to a hierarchy of cues beginning at the least intrusive level (providing the student with as little assistance as possible) and proceeding to the most intrusive level (delivering increasingly more assistance) (Billingsley & Romer, 1983; Schoen, 1986; Wolery & Gast 1984). In this hierarchy, the least amount of assistance should be defined as a prompt most resembling the natural discriminative stimulus while the most assistance cue should be the most artificial with least resemblance to the S^D (Sulzer-Azaroff & Mayer, 1977).

In the literature reviewed, SLP was described as a strategy for the transfereing or shifting of stimulus control from the prompt to the discriminative stimulus (Billingsley & Romer, 1983; Rosenbaum & Breiling, 1976; Wolery & Gast, 1984) and as an error correction procedure used to gain instructional control by fading prompts (Cuvo & Davis, 1983). As a result, numerous terms were used to describe the procedure. A few of those terms include system of least prompts (e.g., Sedlak, Doyle, & Schloss, 1982; Storey, Bates, & Hanson, 1984; Wolery & Gast, 1984), increasing assistance (e.g., Billingsley & Romer, 1983; Schoen, 1986), instructional interaction model (Alberto & Schofield, 1979), instructional cue hierarchy (e.g., Hamre-Nietupski, Nietupski, Sandvig, Sandvig, & Ayres, 1984; Hill, Wehman, & Horst, 1982; Horner & Keilitz, 1975; Schleien & Larson, 1986; Stainback,

Stainback, Wehman, & Spangiers, 1983), less to more assistance or least-to-most intrusive (e.g., Cuvo, Leaf & Borakove, 1978; Giangreco, 1983), the least assistance technique (O'Brien & Azrin, 1972), least-to-most prompt correction for errors (Gaule, Nietupski, & Certo, 1985), correction procedure for wrong answers (Hurlbut, Iwata, & Green, 1982), and levels of assistance feedback (e.g., Vogelsberg & Rusch, 1979). A complete list of the terms used to describe the procedure are shown in Table 1.

Wolery and Gast (1984) suggest four basic guidelines for implementing SLP. First, the natural discriminative stimulus should be presented at each prompt level. Second, the trainer delivers increasingly more information contingent upon student error or no response. Third, a constant response interval (often 5-10 sec) (Billingsley & Romer, 1983) is inserted between the prompt levels which allows the student time to emit an independent response (Lent & Mclean, 1976). Fourth, Wolery and Gast suggest that all correct responses be positively reinforced regardless of the student's response to the least intrusive prompt (e.g., trainer delivers reinforcement for correct responses at all prompt levels). Consequently, a correct response at the least intrusive level would be rewarded followed by an intertrial interval and presentation of the next trial with the opportunity to perform independently. An incorrect response would be consequated by proceeding to the next more intrusive prompt level. This sequence continues until the student emits a correct response. The reinforcement of all correct responses may facilitate the student's acquisition of the skill being taught; however, only those responses occurring in the presence of the natural discriminative stimulus alone count toward criterion.

Table 1

Names Provided in the Literature for the System of Least Prompts

Name	Number of Articles Using this Name	Example Citation
No Name Provided	43	Banerdt & Bricker (1978)
Augmented Verbal Instruction	1	Rynders et al. (1979)
Correction Procedure	1	Nietupski et al. (1983)
Correction procedure for wrong answers	1	Hurlbut et al. (1982)
Defined Modeling Procedure	1	Bellamy & Buttars (1975)
Four Levels of Increasing Assistance	1	Smith & Belcher (1985)
Four Levels of Instruction	1	Friedenberg & Martin (1977)
Four Levels of Prompts	1	Koop et al. (1980)
Graded Sequence of Assistance	1	Tucker & Berry (1980)
Graduated Guidance	1	Lobato & Tlaker (1985)
Graduated Increasing Intervention Hierarchy	1	Duffy & Nietupski (1985)
Graduated Prompt Sequence	1	Cronin & Cuvo (1979)
Graduated Prompting	1	Correa et al. (1984)
Graduated Three Prompt Procedure	1	Thompson & Braam (1982)
Hierarchy of Teacher Questions	1	Alper (1985)
Increasing Assistance	2	Billingsley & Romer (1983)
Instructional Interaction Model	1	Alberto & Shofield (1979)
Instructional Cue Hierarchy	6	Hamre-Nietupski et al. (1984)
Least Assistance Technique	2	O'Brien (1978)
Least Prompting Instruction	1	Pancsofar & Bates (1985)
Least-to-Most Intrusive Prompt Hierarchy	1	Giangreco (1983)
Least-to-Most Prompt Correction for Errors	1	Gaule et al. (1985)
Least-to-Most Restrictive Sequence	1	Walls et al. (1981)
Less to More Assistance	2	Cuvo et al. (1981)
Less to More Intrusive Prompt Sequence	1	Wilson et al. (1984)
Levels of Assistance Training Strategy	1	Noonan (1984)
Prompt Hierarchy	2	Browder et al. (1984)
Sequenced Error Correction Procedure	1	Williams & Cuvo (1986)
Sequential Instructional Program	1	Kissel et al. (1980)
System of Least Prompts	3	Wolery & Gast (1984)
Systematic Error Correction Procedure	1	Schleien et al. (1984)
Systematic Prompt Hierarchy	1	Nietupski & Svoboda (1982)
Systematic Prompting	1	Breen et al. (1985)
Three-Step Cue Hierarchy: Least to Most	1	Schleien et al. (1981)
Vogelsberg's Levels of Assistance	3	Coon et al. (1981)
Wait and See, Least Degree of Assistance	1	Wambold & Salisbury (1978)

All response prompting procedures are designed to increase the probability of correct responses, however, a disadvantage of each procedure is the possibility that students will become overdependent on the selected prompts. In SLP, this may result in the students delaying a response and thus receiving prompts (Schoen, 1986; Falvey, Brown, Lyon, Baumgart, & Schroeder, 1980), learning not to respond (e.g., the student becomes passive, allows the trainer to provide a greater and greater amounts of assistance until a correct response occurs, resulting in more reinforcement for errors than correct responses (Glendenning, Adams, & Sternberg, 1983), or learning to make errors prior to reinforcement (Wolery & Gast, 1984). If these situations occur, modifications should be made to the procedure or another instructional strategy should be used.

Although SLP may initially result in a low ratio of correct responses to errors (Billingsley & Romer, 1983), it allows the student time to respond to the discriminative stimulus occurring in the natural environment and one which non-handicapped persons typically use when performing a particular behavior (Falvey et al., 1980). In addition, the student is allowed to select the level of assistance necessary for a correct response (Wolery & Gast 1984). This process of student prompt selection termed "self fading" by Lent (1974), may result in less training time spent in fading the prompts, facilitating transfer of stimulus control. However, the initial error rate may be higher than with other response prompting strategies such as the most-to-least approach.

A trial sequence for the SLP is shown in Figure 1. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using SLP are shown in Table 2; codes for information presented in Table 2 are found in Appendix A. The behaviors, type and number of prompts, the specified response interval, and consequences for student responses are shown in Table 3.

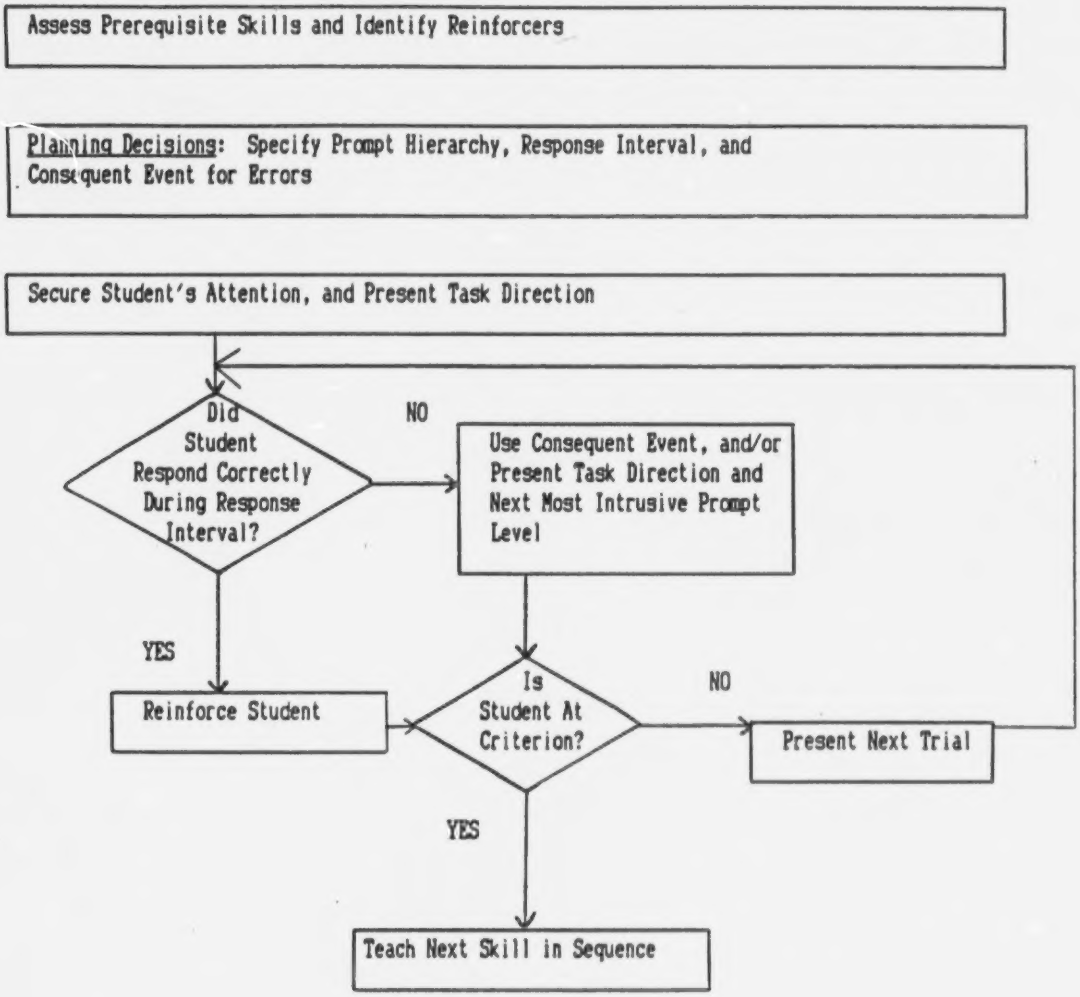
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Specify Prompt Hierarchy, Response Interval, and Consequent Event for Errors
Secure Student's Attention, and Present Task Direction
Did Student Respond Correctly During Response Interval?
NO
Use Consequent Event, and/or Present Task Direction and Next Most Intrusive Prompt Level
YES
Reinforce Student
Is Student At Criterion?
NO
Present Next Trial
YES
Teach Next Skill in Sequence

Figure 6.1 Flow chart depicting the system of least prompts strategy.

Table 2

Results from Investigations Using the System of Least Prompts Strategy

Citation	Population		Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.								
Aeschleman & Schladenauffen (1984)	3M 1F	17-18	SMR	CS	Comm. living; grocery shopping	+	S, M	S = +	W = +	MP
Alper (1985)	1M 2F	17-20	MiMR SMR	CS	Vocat.: library	+	T	S = +m	N/D	MB
Variable 1 - Teacher regulated; Variable 2 - Self regulated										
Azrin et al. (1976)	3M 4F	"average" 31	DD	IN	Self care: Dress, undress	+	S, M	N/D	N/D	PP
Banerdt & Bricker (1978)	1M	2.5	DD	SS	Self Care: self-feeding	+	P/U	N/D	M= +	MP
Bates & Renzaglia (1982)	1M	19	PMR	IN	Lang. Express; label, game	+	N/D	N/D	N/D	MB
Bellamy & Buttars (1975)	5 ND	13.3-20.6	MoMR ED	PS	Comm. living; rote count, count money	+	M, T	T = +/-	A = +	A-B
Breen et al. (1985)	4M 4M	18-21 17-18	MH, Aut N	CS	Social: positive interaction	+	S	S,P= +m	N/D	MB

Table 2 continued.

Citation	Population		Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age Yrs.								
Browder et al. (1984)	8 N/D	24-43	MiMR MoMR SMR	IN	Comm. living; laundry, phone, cooking	+	A	N/D	N/D	MP
Coon et al. (1981)	1F	20	SMR	SS	Comm. living; bus riding	+V1 +V2	N/D	S=-V1	N/D	MB
Variable 1 - Classroom training; Variable 2 - Natural										
Correa et al. (1984)	3M	2.3-4.3	SMR PMR VI	PS	Motor; reach, grasp, skills	+	T	T = +	N/D	MB WTD
Cronin & Cuvo (1979)	4M 1F	17.2-20.6	MoMR	PS	Comm. living; sewing skills	+	P/U	N/D	W = +	MB
Cuvo et al. (1983)	4M 3F	18-22	MiMR SMR	IN	Motor; jump, run	+/-	T	N/D	N/D	MB
Cuvo et al. (1981)	4M 1F	19-21	MiMR MoMR	PS	Comm. living; washer, dryer	+V1 +V2	S,M. P/U	N/D	W= +	MB
Variable 1 - Prompt sequence, task 2; Variable 2 - Prompt sequence III, task 3										
Cuvo et al. (1978)	3M 3F	13-15	MoMR	PS	Vocat.; clean rest rooms	+	S. P/U	S= +	W= +	MB

Table 2 continued.

Citation	Population									
	Number / Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Duffy & Nietupski (1985)	1F	20	PMR	IN	Leisure; video game	+	N/D	N/D	W= +	MP
Duker & Michielson (1983)	1M 2F	8.8-16.2	MoMR SMR	IN	Language; manual sign	+	S	T,S,P= +	N/D	MB
Duker & Moonan (1985)	1M 2F	11.7-14.3	MoMR SMR DD	IN	Lang.; manual sign mands	+	P/U	T,S,P= +	N/D	MB
Duker & Morsink (1984) Exper. I Exper. II	2F 2M	22;23 8;13.3	DD DD AUT	IN IN	Lang; manual signs	+ E1 + E2	S	S = +/-	M = +/-	MB
Freagon & Rotatori (1982)	6M 4F	10-17	SMR PMR	IN	Self Care; teeth, deod., hands	+	N/D	M,S= +	M,W= +	GR
Variable 1 - Artificial environment/training; Variable 2 - Natural environment/generalization										
Friedenberg & Martin (1977)	2M	21;30	SMR	IN	Vocat.; stapling	+ V1 + V2	M = V2<V1 E = V2<V1	N/D	N/D	A-B-A-C-A
Variable 1 - Hand stapling; Variable 2 - Machine stapling										

Citation	Population Number / Gender	Age/ Yrs.	Diag-nosis	Setting	Behavior	Effective-ness	Efficiency	Generali-zation	Mainten-ance	Design
Gaule et al. (1985)	3M	17-20	MoMR	PS	Grocrey; list, locate, purchase	+	N/D	N/D	W = +/-	MP
Giangreco (1983)	1M	20	SMR	PS CS	Leisure; photo skills	+	S	S = +	W,M= +	MP
Greer et al. (1985) Exper. II	3M	22-26	SMR PMR	IN	Social; positive play	+	S	N/D	M = +	MB
Halasz-Dees & Cuvo (1986)	1M 4F	19-33	MIMR	IN	Leisure: macrame knots	+ V1 V2	N/D	S,T= +	N/D	MB
Variable 1 - Easy steps sequence; Variable 2 - Difficult steps sequence										
Hamre-Nietupski et al. (1984)	2M	17;19	MH	IN	Leisure: tape player	+	T	N/A	M = + A = +m	MP
Haring (1985)	3M 1F	4.2- 7.10	MoMR SMR	SS	Social; positive toy play	+	S	T = +/-m	N/D	MP
Hill et al. (1982)	3M	14-21	SMR	CS	Leisure: pinball play	+	N/D	S = +m	A = +	MB
Hopper & Wambold (1978)	3M 1F	4-13	DD	PS	Social; positive toy play	+/-	N/D	N/D	N/D	PP

Table 2 continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Horner & Keilitz (1975)	6M 2F	9-17	MiMR MoMR	IN	Self care; tooth brushing	+/- V 1, V 2	S, P/U	N/D	N/D	MB
Variable 1 - Token + social; Variable 2 - Social replication group										
Horner & McDonald (1982)	4 N/D	16-18	MoMR SMR	PS	Vocat.; crimp, cut, electrical capacitators	+ V1,V2	E = V2<V1 S = V1 = V2 T = A	T V2 > V1	N/D	MB
Variable 1 - Single; Variable 2 - Case										
Horner et al. (1981)	1m 2F	24-52	SMR	CS	Vocat.; components circuit board	+ V1 > V2	M= V2 >V1	N/D	N/D	MB WTD
Variable 1 - CRF; Variable 2 - Extinction										
Hunter & Bellamy (1976)	3F	19-26	DD	CS	Vocat.; cable harness	+	S, M	N/D	N/D	N/D
Hupp & Mervis (1981)	6 N/D	8-18	SMR	IN	Lang; manual signs	+ V1,V2,V3	N/D	T = V3>V1 V3>V2	N/D	RM
Variable 1 - one good exemplar; Variable 2 - good/poor exemplars; Variable 3 - 3 good exemplars										
Hupp et al. (1986)	N/D	5-19	SMR	PS	Lang. Recept./ express; i.d. pictures	+/-	N/D	T = V1>V2	N/D	GR
Variable 1 - Receptive training; Variable 2 - Expressive training										

Table 2 continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.	Diagnosis							
Hurlburt et al. (1982)	3M	14-18	MH	PS	Lang.: manual signs	+ V1, V2	T = V2 < V1	T = V2 > V1	D = V2 > V1 A = V2 > V1	AT
Variable 1 - Bliss comm.; Variable 2 - Iconic comm.										
Janssen & Guess (1978)	4 N/D	13-17	PMR	IN	Lang.: Recept. I.D.	+ V2 > V1	M, A = V2 < V1	N/D	N/D	VTD
Variable 1 - Label task direction; Variable 2 - label/function task direction										
Kissell et al. (1980)	1F	25	PMR	PS CS	Self care: feeding skills	+	N/D	S = +m	V, M = +	MB
Kohl (1981)	7M 1F	5.4-17.2	SMR	PS SS	Lang.: manual sign	+ V1 - V6	M = V1 = V2 V3 < V4 V5 < V6	N/D	N/D	GR
Variable 1 - iconic stimuli; Variable 2 - abstract; Variable 3 - touch; Variable 4 - non touch; Variable 5 - symetrical; Variable 6 - assymetrical										
Kohl et al. (1978)	2M 1F	7-8	MoMR	PS	Lang.; manual sign	+ V1,V2	M = V1 < V2	S, P, T = +/- V1, V2	D = + V1, V2	A-B
Variable 1 - Group training; Variable 2 - Individual training										
Koller & Mulhern (1977)	6 N/D	Adolescents	DD	CS	Acad.: math problems	+ V1 > V2	M = V1 < V2	N/D	A = V1 > V2	PP
Variable 1 - Calculator sequence; Variable 2 - Computation sequence										

Table 2 continued.

Citation	Population									
	Number / Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Konstantareas (1984)	12M 2 F	4-11	DD	PS	Lang: prep., pronoun sentences	+ / - V2 > V1	T	N/D	D = V2 > V1	ANOVA
Variable 1 - Word/prompt sequence; Variable 2 - sign/word prompt sequence										
Koop et al. (1980)	8M 1F	18-64	SMR	IN	Vocat.: bike, brake, reel, assembly	+ / -	M, T, E = V2 < V1	N/D	N/D	AT
Variable 1 - minimum social reinforcement; Variable 2 - Socials plus edibles										
Lagomarcino et al. (1984)	3M 2F	14-19	SMR PMR	IN	Leisure: dance skills	+ / -	N/D	S, P = + / -	N/D	MB
Livi & Ford (1985)	2M 1F	9-11	MoMR SMR	PS	Comm. living; toast, snacks, lunch	+	N/D	S = +m	N/D	PP
Lobato & Tlaker (1985)	1M	13	SMR	CS	Comm. living; bed, tooth brushing	+ / -	S	N/D	N/D	MB WTD
Marchant & Wehman (1979)	4 N/D	8-10	DD	PS	Leisure: Lotto game	+	N/D	S, P = - A	N/D	MP

Table 2 continued.

Citation	Population Number / Gender	 Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Marchetti et al. (1984)	27 N/D	17-59	MiMR MoMR SMR	IN	Comm. living; bus riding	+ V1,V2,V3 V3>V2,V1	N/D	S = V1,V2,V3	N/D	GR
Variable 1 - Classroom setting; Variable 2 - Community setting; Variable 3 - Facilty/grounds setting										
Martin et al. 1984 Exper. II	1M 1F	30	MiMR	CS	Vocat.; supervisor training	+	N/D	N/D	M,A= +	MB
Matson et al. (1980)	75 N/D	$\bar{X}$= 33.9	MoMR SMR PMR	IN	Comm living; shower, wardrobe, nightstand maintenance	+ V1>V2,V3	N/D	N/D	W = +	GR
Variable 1 - Independent SLP; Variable 2 - Standard SLP; Variable 3 - No training										
McDonnell et al. (1984)	3M 1F	16 - 19	MoMR SMR	PS CS	Comm living; grocery purchase	+ V1,V2	N/D	S = + m V1, V2	M = + V1, V2	MB
Variable 1 - Slide; Variable 2 - Flashcard										
Mithaug (1978)	1M	16	SMR	PS	Language; objects, prepositions	+ V1, V2, V3	N/D	T = V3 > V1, V2	N/D	MB
Variable 1 - Object training; Variable 2 - Preposition training; Variable 3 - Object/preposition training										

Table 2 continued.

Citation	Population		Diagnosis	Setting	Behavior	Effectiiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.								
Nietupski & Svoboda (1982)	3M 3F	22-64	SMR PMR	IN	Leisure; Lotto game	+	M, T	S, P = +	W = +	N/D
Nietupski et al. (1983)	4M	19-21	MoMR SMR	PS	Comm. living; grocery shopping	+	S, T, P/U	S = +	M = + / -	MP
Noonan (1984)	3M 4F	2-12	DD	PS	Motor: 1. postural 2. ATNR 3. patterns	+/-V1 -V2 -V3	N/D	N/D	N/D	MB
O'Brien (1978)										
Variable 1 -	2M 5F	26-59	SMR	IN	Language, concepts	+ V1	M, T	N/D	N/D	A - B
Variable 2 -	3M 2F	5-54	MoMR	IN		+ V2				
Variable 1 - Colors; Variable 2 - Numbers, letters										
O'Brien & Azrin (1972)										
Exper. I	11	$\bar{X}$= 31	$\bar{X}$= SMR	IN	Self care: proper mealtime behavior	+ V1>V2	E,P/U V1<V2	Exp. 2 S= + m	D= + m M= +	GR
Variable 1 - Training; Variable 2 - Control										
Pancsofar & Bates (1985)	1M 3M	9-18	SMR	PS	Self care: soap dispensor	+	N/D	S, T = +/- m	N/D	MB

Citation	Population		Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.								
Rae & Roll (1985)	4M 6F	22-42	PMR	CS	Comm Living; fire drill	+	M	A, T = +	V = +	A-B
Richman et al. (1984)	5F	28-44	MiMR MoMR SMR	IN	Self Menstrual care	+	S, M	N/D	M = + / -	MB
Rosenbaum & Breiling (1976)	1F	12	SMR AUT	PS	Acad.; reading comprehension	+	S, M	T = +	N/D	MB WTD
Rynders et al. (1979)	35 2M:1F	$\bar{X}$=3	DD N	PS	Pre-academic and self care skills	+ / - V 2 > V1	N/D	N/D	N/D	GR
Variable 1 - Augmented instruction; Variable 2 - Repeat verbal instructions										
Schleien et al. (1981)	1F	28	PMR	CS	Comm. Living; cooking skills	+	S	S, T = +	N/D	MB
Schleien et al. (1984)	1M	16	SMR	SS	Leisure: bowl, snack	+	N/D	S, T = +	V = +	MB
Schleien & Larson (1986)	2M	27;29	SMR	CS	Leisure: games at rec. center	+	S	S=+ A,T=+	M= +	MB
Schleien et al. (1981)	2M 1F	23-63	SMR PMR	CS	Leisure: dart game	+	N/D	S = +	M = +	MB CC

Table 2 continued.

Citation	Population		Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number / Gender	Age/ Yrs.								
Sedlak et al. (1982)	1 M 2 F	18-19	SMR PMR	IN	Leisure; video game	+	S	S, T = + m	M = + m	MB
Smeets et al. (1985)	3 M 1 F	7.8 - 12	MiMR MoMR	IN	Comm. living; time, appointments	+	N/D	S = +	Post Probe +	MP
Smith & Belcher (1985)	2 M 3 F	22 - 40	AUT	IN	Comm. living; domestic skills	+	N/D	N/D	N/D	A - B
Sowers et al. (1979)	1 M	20	DD	CS	Comm. living bus ride	+	S	N/D	+	N/D
Spears et al. (1981)	1 M	12	MR	IN	Comm. living; indep. travel	+	S, P/ U	N/D	N/D	MB VTD
Spooner & Hendrickson (1976)	4 M 3 F	16 - 22	SMR PMR	CS	Vocat.; assembly skills	+	S	S = + m	N/D	N/D
Stainback et al. (1983)	1 M 2 F	23 - 41	PMR	IN	Motor; three exercises	+	S	S, T = +	A = +	MB

Table 2 continued.

Citation	Population Number / Gender	 Age/ Yrs.	Diag- nosis	Setting	Behavior	Effective- ness	Efficiency	Generali- zation	Mainten- ance	Design
Storey et al. (1984)	2 M 4 F	25 - 74	MiMR MoMR SMR	CS	Comm Living; coffee purchase	+/-	S	S = +	M = +	MP
Thompson & Braam (1982)	3 M	12 - 24	MiMR MoMR	PS	Comm. living; laundry skills	+	N/D	S = +/-m	M = +/-	MP
Tucker & Berry (1980)	5 M 1 F	15.6 - 22.3	MoMR SMR PMR MH	IN	Self care; hearing aid	+	N/D	S = +/-m	W = +	MB
van den Pol et al. (1981)	3 M	17 - 22	MoMR	PS	Comm living; restaurant skills	+	N/D	S = +	Y = +	MB
Vogelsberg et al. (1981)	2 M 1 F	17 - 21	SMR	CS	Comm. Living; street crossing	+/A	N/D	S = +	M = +	MB
Wacker el al. (1980)	2 M 2 F	6 - 9	MoMR	PS	Vocat.: assembly skills	+	S	S = +	W = +	MB
Walker & Vogelsberg (1985)	1 F	22	PMR	CS	Motor: cruise table	+/-	N/D	N/D	N/D	MB

Table 2 continued.

Citation	Population Number / Gender	 Age/ Yrs.	Diag-nosis	Setting	Behavior	Effective-ness	Efficiency	Generali-zation	Mainten-ance	Design
Walls et al. (1981)	7 M 8 F	19 - 49	MiMR MoMR	CS	Vocat.; tool usage	+ = V1 V2	M = V1 < V2 E = V1 < V2 P/U	N/D	N/D	GR
	Variable 1 - operations pretraining; Variable 2 - no pretraining									
Vambold & Bailey (1979)	4 M 2 F	6.2 - 13. 6	SMR PMR	CS	Social; positive toy play	+/-	N/D	S, T = A +	N/D	PP
Vambold & Salisbury (1978)	N/D	4 - 16	DD	SS	Self care; toilet skills	+	N/D	S, P = +	Y = +	N/D
Wehman et al. (1979)	3 M	18 - 22	DD MiMR	CS	Vocat.; job training	+	P/U	N/D	N/D	N/D
Wehman et al. (1978)	E 1 N/D	16-33	PMR SMR	SS	Leisure; fitness, games	+	N/D	N/D	N/D	MB
	E 2 N/D	13-16				+/-	N/D	N/D	N/D	MB
Wehman et al. (1980)	1 F	23	MH	IN	Leisure; photo skills	+	N/D	S = +	N/D	TT
Williams & Cuvo (1986)	3 M 3 F	19 - 33	MiMR BMR	CS	Comm. living; apartment maintenance	+ V1 V2	M, T V2 < V1	P, S = +	M = +	MP
Wilson et al. (1984)	2 M 2 F	16 - 19	PMR	IN	Comm. living; family dining	+/-	N/D	N/D	V = +	MP

Table 3

Methods from Investigations Using the System of Least Prompts Strategy

Citation	Population Number/Diagnosis	Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
		Name	Type					
Aeschleman & Schladenhauffen (1984)	4 SMR	Comm. living; grocery shop	Ch	1. I/VI (SD) 2. SD, MO 3. SD, VI 4. FP	N/D	X	social praise	present next prompt level
Alper (1985)	3 MiMR SMR	Vocat; library work	Ch	1. I/VI (SD) 2. SD/general 3. SD/inference 4. SD/explanation 5. SD/identification	10 sec	X	social praise	present next prompt level
Azrin et al. (1976)	7 DD	Self care; dress, undress	Ch	1. I/VI (SD) 2. SD, G 3. SD, PP 4. SD, GG	A	N/D	social praise, stroking	present next prompt level
Banerdt & Bricker (1978)	1 DD	Self care; self-feeding	DS	1. I/VI (SD) 2. VI, G 3. PP/prompt 4. FP/mandate	10 sec.	X	edible	present next prompt level
CODES	See Appendix A	See Appendix A	Ch = chained DS = discrete	IVI = indirect verbal instruction VI = verbal instruction SD = discriminative stimulus MO = model G = gesture PP = partial physical manipulation FP = full physical manipulation EC = error correction I = independent GG = graduated guidance	arabic numeral (sec) A = anecdotal N/D = not defined	X = occurred A = anecdotal N/D = not defined R+ = correct response	FR = fixed ratio reinforcement VR = variable ratio reinforcemenet CRF = continuous reinforcement N/D = not defined	VR = verbal reprimand FP = full physical VI = verbal instruction MO = model NR = no response

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Bates & Renzaglia (1982)	1	PMR	Lang. express; label, game	DS	1. I/VI (SD) 2. VI/directions 3. VI, MO 4. VI, VI/direct, MO	5 sec	X	social praise, pennies at end of game	present next prompt level
Bellamy & Buttars (1985)	5	MoMR ED	Comm Living; rote count, count money	DS	1. I/VI (SD) 2. MO 3. FP/priming	N/D	N/D	social praise, compliments, points	present next prompt level
Breen et al. (1985)	8	MH AUT N	Social; positive interaction	DS	1. I/VI (SD) 2. IVI 3. VI 4. G 5. PP 6. FP	3 sec	X	social praise	present next prompt level
Browder et al. (1984)	8	MiMR MoMR SMR	Comm. living; laundry, phone, cooking	Ch	1. I/VI (SD) 2. VI 3. G, 4. MO	5 sec	Differential reinforcement on equivalent R+ or R+ occuring at less intrusive levels	social praise	present next prompt level
Coon et al. (1981)	1	SMR	Comm. living; bus riding	Ch	V1 1. I/VI (SD) 2. VI 3. MO 4. remedial V2 1. I/VI (SD) 2. SD, Mo 3. SD, PP 4. SD, FP	N/D	N/D	praise	present next prompt level
Variable 1- classroom training; Variable 2- natural									
Correa et al. (1984)	3	SMR PMR VI	Motor; reach, grasp skill	DS	1. I, object/ auditory 2. VI, auditory 3. PP, auditory 4. FP, auditory	10 sec	N/D	praise	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Cronin & Cuvo (1979)	5	MoMR	Comm. living; sewing skills	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP 5. VI, visual/ finished product	5 sec	N/D	FR 4 praise, star	present next prompt level
Cuvo et al. (1983)	7	MoMR SMR	Motor; jump, run	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	N/D	N/D	N/D	VR, present next prompt level
Cuvo et al. (1981)	5	MiMR MoMR	Comm. living; washer, dryer	Ch	V1 1. I/No help 2. VI 3. VI,MO 4. VI, FP V2 1. I/confirmation 2. IVI 3. VI 4. VI,MO 5. VI,FP	5 sec	N/D	Descriptive praise	present next prompt level
Variable 1- prompt sequence II; Variable 2 -prompt sequence III									
Cuvo et al. (1978)	6	MoMR	Vocat.; clean rest rooms	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	5 sec	N/D	VR, praise, M & M	present next prompt level
Duffy & Nietupski (1985)	1	PMR	Leisure; video game	Ch	1. I/VI(SD) 2. I/VI 3. VI, G 4. FP	N/D	N/D	opportunity to continue game	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Duker & Michielson (1983)	3	MoMR SMR	Language; manual sign	DS	V1 1. Most-least(SD) 2. 1/3 PP 3. 2/3 PP 4. FP V2 1. Most-to-least (SD) 2. 1/3 MO 3. 2/3 MO 4. MO V3 1. Most-to-least SD 2. 1/3 G 3. 2/3 G 4. G	5 sec	X	praise, edibles, drink	NR - present next prompt level Error- VR, FP
Variable 1- sequence 1; Variable 2 -Sequence 2; Variable 3 - sequence 3									
Duker & Moonan (1985)	3	MoMR SMR DD	Lang; manual sign mands	DS	1. I/VI(SD) 2. VI, G 3. VI, MO 4. VI, FP	5 sec	X	praise, received manded object	NR-next prompt; error-physical interruption
Duker & Morsink (1984) Exp. I	2	DD	Lang.; manual signs	DS	V1 1. Most-least(SD) 2. 1/3 PP 3. 2/3 PP 4. FP V2 1. most-to-least SD 2. 1/3 MO 3. 2/3 MO 4. MO V3 1. most-to-least SD 2. 1/3 G 3. 2/3 G 4. G	5 sec	X	received manded object for 10 sec or drink	NR-next prompt error- VR, FP, MO, VI

Variable 1- sequence1; Variable 2-sequence 2; Variable 3-sequence 3

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Freagon & Rotatori (1982)	10	SMR PMR	Self care; teeth, deodorant, hands	Ch	1. I/No help 2. VI 3. MO 4. FP	N/D	X	social praise	present next prompt level
	Variable 1 - artificial environment/training;				Variable 2 - natural/generalizaton				
Friedenberg Martin (1977)	2	SMR	Vocat.: stapling	Ch	1. I/VI (SD) 2. verbal explanation of errors/SD 3. SD, VI 4. SD, MO 5. prime (FP)	N/D		no reinforcers delivered during training trials	present next prompt level
Gaule et al. (1985)	3	MoMR	Grocery list; locate, purchase	Ch	1. I/MO (SD) 2. VI 3. VI, MO 4. VI, FP	N/D	N/D	social, verbal praise	present next prompt level
Giangreco (1983)	1	SMR	Leisure; photo skills	Ch	1. I/VI (SD) 2. VI 3. G 4. MO 5. FP	5 sec	N/D	social praise	interrupt error, VI and present next prompt level
Greer et al. (1985) Exp. II	3	SMR PMR	Social; positive play	DS	1. MO, VI (SD) 2. PP 3. FP	10 sec	X	social praise; edibles	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
Balasz-Dees & Cuvo (1986)	5	MiMR	Leisure; macrame knot	Ch	V1 1. I/No help 2. Visual, finished product 3. Visual, picture of how to tie 4. Visual, card/ picture 5. VI, MO 6. VI, FP V2 1. I/No help 2. VI, MO 3. VI, FP	N/D	N/D	positive feedback at no help level	present next prompt level
Variable 1- Easy steps sequence; Variable 2 - Difficult steps sequence									
Hamre-Nietupski et al. (1984)	2	MH	Leisure tape player	Ch	1. I/VI (SD) 2. G 3. PP 4. FP	N/D	N/D	physical praise, music	present next prompt level
Haring (1985)	4	MoMR SMR	Social; positive toy play	DS	1. I/VI (SD) 2. VR, VI, MO 3. VR, VI, FP	10 sec	X at all levels except FP	praise	present next prompt level
Hill et al. (1982)	3	SMR	Leisure; pinball play	Ch	1. I 2. VI 3. MO 4. G 5. FP	10 sec	X	social praise	present next prompt level
Hopper & Wambold (1978)	4	DD	Social; positive toy play	DS	1. I 2. MO 3. FP 4. consequence for error	N/D	N/D	play with toy	present next level, lose toy at 4.
Horner & Keilitz (1975)	8	MiMR MoMR	Self care; tooth-brushing	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	5 sec	X	tokens and/or praise	present next level, FP at 4th level followed by return to I/ No help

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Horner & McDonald (1982)	4	MoMR SMR	Vocat.; crimp, cut electrical capacitators	Ch	1. I/No help 2. VI 3. MO 4. FP	5 sec	N/D	praise	present next prompt level
Horner et al. (1981)	3	SMR	Vocat.; components circuit bd	Ch	1. I/No help 2. VI 3. MO 4. FP	5 sec	N/D	praise	present next prompt level
Hunter & Bellamy (1976)	3	DD	Vocat.; cable harness	Ch	1. I/No help 2. VI, IVI 3. MO 4. FP	N/D	N/D	social praise, money at task completion	present next prompt level
Hupp & Mervis (1981)	6	SMR	Lang.; manual signs	DS	1. I/VI(SD) 2. repeat VI(SD) 3. SD, VI 4. SD, MO 5. SD, PP 6. SD, FP	N/D	N/D	imitation of correct response, social, physical, praise	present next prompt level
Hupp et al. (1986)	N/D	SMR	Lang. recept./ express.; id. pictures	DS	V1 1. I/VI(SD) 2. SD, G 3. SD,MO 4. FP V2 1. I/VI(SD) 2. repeat 3. VI 4. SD, MO 5. SD, PP 6. SD, FP	N/D	X after second SD	praise, hold photo	present next prompt level

Variable 1- receptive training; Variable 2-expressive training

Hurlburt et al. (1982)	3	MH	Lang.; manual sign	DS	1. I/VI(SD) 2. SD, G, MO 3. SD, G, MO, VI 4. SD, G, MO, VI FP	N/D	X	social praise alone at prompt levels	present next prompt level
Janssen & Guess (1978)	4	PMR	Lang; recept. id	DS	1. I/VI(SD) 2. MO 3. FP	N/D	X I and MO only	social praise	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Kissel et al. (1980)	1	PMR	Self-care; feeding skills	Ch	1. I/No help 2. VI 3. VI, G, PP 4. VI, FP	3 sec	X	social praise	5 sec ignore, present next prompt level
Kohl (1981)	8	SMR	Lang.; manual sign	DS	1. I/VI(SD) 2. SD, MO 3. SD, PP 4. SD, FP	5 sec	X	edibles, and/or social praise	present next prompt level
Kohl et al. (1978)	3	MoMR	Lang.; manual sign	DS	1. I/VI(SD) 2. MO 3. FP	Trainer varied response interval using PTD	reinforce unprompted correct only	social praise	present next prompt level
Koller & Mulhern (1977)	6	DD	Academic; math problems	DS	V1 1. I/VI(SD) 2. SD,G 3. FP V2 1.I/VI(SD) 2. SD, MO 3. SD, MO, FP	N/D	N/D	N/D	present next prompt level
Variable 1- caculator sequence; Variable 2- computation sequence									
Konstantareas (1984)	14	DD	Lang.; preposition pronoun sentences	DS	V1 1. I/VI(SD) 2. VI(partial) 3. VI(full) V2 1. I/VI(SD) 2. VI(partial), MO(sign) 3. VI(full), MO (sign), MO(word)	N/D	N/D	N/D	present next prompt level
Variable 1-word/prompt sequence; Variable 2- sign/ word/prompt sequence									
Koop et al. (1980)	9	SMR	Vocat.; bike, brake reel assembly	Ch	1. I 2. VI 3. VI, G 4. VI, FP	10 sec	N/D	N/D	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Lagomarcino et al. (1984)	5	SMR PMR	Leisure; dance skills	Ch	1. I/music 2. VI 3. MO 4. FP	N/D	N/D	inter-mittent social praise	present next prompt level
Livi & Ford (1985)	3	MoMR SMR	Comm. living; toast, snack, lunch	Ch	1. I/VI 2. MO 3. FP	N/D	N/D	N/D	present next prompt level
Lobato & Tlaker (1985)	1	SMR	Comm. living; bed, tooth brushing	Ch	1. I/No help 2. VI 3. G 4. FP	2 sec	A	social, verbal, physical, praise	present next prompt level
Marchant & Wehman (1979)	4	DD	Leisure; Lotto game	Ch	1. I 2. VI 3. MO 4. FP	N/D	N/D	N/D	N/D
Marchetti et al. (1984)	27	MiMR MoMR SMR	Comm. living; bus riding	Ch	1. I/VI(SD) 2. VI 3. G 4. FP	N/D	X following a prompted sequence but not at each prompt level	social, physical praise	present next prompt level
Martin et al. (1984) Exp. 2	2	MiMR	Vocat.; supervisor training	Ch	1. I/VI(SD) 2. IVI 3. VI 4. repeat 3 5. VI, MO, role playing	N/D	N/D	social praise	present next prompt level
Matson et al. (1980)	75	MoMR SMR PMR	Comm. living shower, wardrobe, nightstand maintenance	Ch	1. I/VI(SD) 2. VI(SD), MO 3. VI(SD), FP	N/D	A reinforcer delivered 'when applicable'	social praise, tangible	present next prompt level
Variable 1- Independent SLP; Variable 2- Standard SLP; Variable 3- No training									
McDonnell et al. (1984)	4	MoMR SMR	Comm. living; grocery purchase	Ch	1. I 2. VI 3. MO 4. FP	10 sec	X	social praise	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior Name	Behavior Type	Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
Mithaug (1978)	1	SMR	Lang.; objects, preposition	DS	1. I/VI(SD) 2. MO 3. FP	N/D	N/D	social praise	VR, present next prompt level
Nietupski & Svoboda (1982)	6	SMR PMR	Leisure; lotto game	Ch	1. I 2. IVI 3. VI 4. MO 5. FP	N/D	N/D	social, physical praise, edibles	present next prompt level
Nietupski et al. (1983)	4	MoMR SMR	Comm. living; grocery shopping	Ch	1. I/VI, MO(SD) 2. VI 3. MO 4. FP	N/D	X	social praise	present next prompt level
Noonan (1984)	7	DD	Motor; 1. postural 2. ATNR 3. patterns	DS	1. I/No help 2. VI and/or G 3. PP 4. FP	5 sec	X	social praise	present next prompt level
O'Brien (1978)									
Var. 1	7	SMR	Language: concepts	DS	1. I/VI, MO(SD) 2. VI 3. VI, MO 4. VI, FP	N/D	X	diet soda	present next prompt level
Var. 2	5	MoMR							
Variable 1-colors; Variable 2- numbers,letters									
O'Brien & Azrin (1972) Exp. 1	11	SMR	Self-care: proper mealtime behavior	DS	1. VI(SD) 2. VI(SD), MO 3. VI(SD), FP	N/D	If correct, go to no assistance level	meal	present next prompt level if error on assisted trial; present last previous prompt if error on unassist. trial
Pancsofar & Bates (1985)	4	SMR	Self-care: soap dispenser	DS	1. I/No help 2. VI 3. VI, G 4. VI, FP	5 sec	X reinforce when soap obtained	social praise, liquid or edible	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Rae & Roll (1985)	10	PMR	Comm. living; fire drill	DS	1. I/VI(SD) 2. VI, G 3. PP 4. FP	30 sec	N/D	social praise	present next prompt level
Richman et al. (1984)	5	MiMR MoMR SMR	Self-care; menstrual care	Ch	1. I/VI(SD) 2. VI 3. MO 4. FP Note: #3 & #4 never needed	5 sec	N/D	social praise	present next prompt level
Rosenbaum & Breiling (1976)	1	SMR Aut	Academic; reading comprehension	DS	1. I/visual(SD) 2. EC, VI, visual 3. EC, VI, visual, MO 4. EC, VI, visual, FP 5. EC, VI, visual, FP(3x)	10 sec	X	social praise, candy	removed card; 10 sec pause - then present next prompt level
Rynders et al. (1979)	35	DD N	Preacadem; self-care; skills	DS	V1 1. I/VI(SD) 2. VI 3. VI, MO 4. VI, FP	15 sec, 30 sec for puzzle task	N/D	N/D	present next prompt level
		Variable 1-	augmented instruction						
Schleien et al. (1981)	1	PMR	Comm. living; cooking skills	Ch	1. I/VI(SD) 2. VI(SD), MO 3. VI(SD), FP	N/D Note: Authors refer to Horner & Keilitz (1975); probable response interval 5 sec	X	social praise	present next prompt level
Schleien & Larson (1986)	2	SMR	Leisure; game, recreation center	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	N/D	X	social praise	present next prompt level

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Schleien et al. (1981)	3	SMR PMR	Leisure; dart game	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	N/D	X	social praise	present next prompt level
Sedlak et al. (1982)	3	SMR PMR	Leisure; video game	Ch	1. I/No help, MO 2. VI 3. VI, MO 4. VI, MO, FP 5. repeat 4	A	N/D	N/D	present next prompt level
Smeets et al. (1985)	4	MiMR MoMR	Comm. living; time, appoint-ments	DS	1. I/MO 2. VI 3. MO 4. FP	N/D	N/D	social praise	present next prompt level
Smith & Belcher (1985)	5	Aut	Comm. living; domestic skills	Ch	1. I/No help 2. VI 3. VI, MO, G 4. VI, FP	5 sec	N/D	N/D	present next prompt level
Sowers et al. (1979)	1	DD	Comm. living; bus riding	Ch	1. I/No help 2. VI 3. VR, VI 4. VI, FP	N/D	X after level 2 only	social praise	present next prompt level
Spears et al. (1981)	1	MR	Comm. living; independent travel	Ch	1. I/No assist. 2. VI, MO, G 3. PP 4. FP	3 sec	N/D	social praise	present next prompt level
Spooner & Hendrickson (1976)	7	SMR PMR	Vocat; assembly skills	Ch	1. I/No help 2. VI 3. G 4. FP	N/D	N/D	social praise	present next prompt level if NR. FP if error
Stainback et al. (1983)	3	PMR	Motor; three exercises	Ch	1. I/No help 2. VI, MO 3. G 4. FP	A	N/D	social praise	present next prompt level
Storey et al. (1984)	6	MiMR MoMR SMR	Comm. living; coffee purchase	Ch	1. I/No help 2. VI 3. VI, G 4. VI, PP 5. VI, FP	3 sec	N/D	social, physical praise, coffee	present next prompt level

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Thompson & Braam (1982)	3	MiMR MoMR	Comm. living; laundry skills	Ch	1. I/No help 2. VI 3. MO 4. GG	5 sec	N/D	tokens	present next prompt level
Tucker & Berry (1980)	6	MoMR SMR PMR MH	Self-care: hearing aid	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	5 sec	X	social praise	present next prompt level. If error occurred at level 4, proceed to next step-Level 1
van den Pol et al. (1981)	3	MoMR	Comm. living; restaurant skills	Ch	1. I/No help 2. VI feedback remedial trial 3. MO, VI 4. MO, VI, repeat until correct	N/D	X	descriptive social praise	present next prompt level
Vogelsburg et al. (1981)	3	SMR	Comm. living; street crossing	Ch	1. I/VI(SD) 2. VI 3. VI, MO 4. VI, PP 5. VI, PP	5 sec	N/D	N/D	present next prompt level
Wacker et al. (1980)	4	MoMR	Vocat.: assembly skills	Ch	1. I/MO, No help 2. VI 3. MO 4. FP	A	X	social praise	present next prompt level
Walker & Vogelsberg (1985)	1	PMR	Motor: cruise at table	Ch	1. I/MO, No help 2. VI 3. VI, G 4. VI, PP 5. VI, FP	3 sec	N/D	praise	Phase A: present next prompt level both incorrect and no response. Phase B: present FP for incorrect

Table 3 continued.

Citation	Population Number/Diagnosis		Behavior		Prompt Hierarchy Sequence	Response Interval (sec)	Prompted Corrects Reinforced	Type of Reinforcer	Errors
			Name	Type					
Walls et al. (1981)	15	MiMR MoMR	Vocat.; tool usage	Ch	1. I/"overall cue" 2. VI 3. VI, G 4. VI, MO	30 sec	X	praise	present next prompt level
Wambold & Bailey (1979)	6	SMR PMR	Social; positive toy play	DS	1. I/No help 2. MO 3. MO 4. FP	N/D	N/D	N/D	present next prompt level and VR for incorrect
Wambold & Salisbury (1978)	N/D	DD	Self-care; Toileting skills	DS	1. I/No help 2. VI 3. VI, PP, G, MO 4. VI, FP	A	X	social, physical praise	present next prompt level
Wehman et al. (1979)	3	DD MiMR	Vocat.; job training	DS	1. I/No help 2. VI 3. VI, G 4. VI, FP	N/D	N/D	wages	present next prompt level
Wehman et al. (1978)									
Exp.1	N/D	PMR	Leisure; fitness, games	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	10 sec	X	social praise	present next prompt level
Exp. 2	N/D	SMR							
Wehman et al. (1980)	1	MH	Leisure; photo skills	Ch	1. I/No help 2. VI 3. VI, MO 4. VI, FP	15 sec	X	social praise	present next prompt level
Williams & Cuvo (1986)	6	MiMR BMR	Comm. living; apartment maintenance	Ch	1. I/No help 2. VI 3. MO 4. VI, MO 5. FP	N/D	N/D	social praise	present next prompt level
Wilson et al. (1984)	4	PMR	Comm. living; family dining	Ch	1. I/VI(SD) 2. VI 3. VI, MO 4. VI, FP Note: omitted MO in training	3 sec	X differential reinforcement for requiring less assist.	edible, social, descriptive praise	present next prompt level

Description of Procedure

Population

SLP was implemented with a diverse population. The chronological ages ranged from preschool to adult and the handicapping conditions ranged from borderline to profound mental retardation. Although Wolery and Gast (1984) suggest that this procedure might be most effective with those students who are imitative, most of the studies reviewed do not delineate prerequisite skills for use of SLP.

A variety of the studies used SLP with preschoolers, 2.0-4.0 years of age (e.g., Banerdt & Bricker, 1978; Correa, Poulson, & Salzberg, 1984; Haring, 1985; Noonan, 1984). Elementary aged students and adolescents also were included in the SLP studies; they ranged in age from 5.0 years to 17.0 years (e.g., Duker & Michielson, 1984; Freagon & Rototari, 1982; Horner & Keilitz, 1975; Hupp & Mervis, 1981; Rosenbaum & Breiling, 1976; Smeets, Lancioni, & VanLieshout, 1985; Wacker, Carroll, & Moe, 1980; Wambold & Bailey, 1979). Adults, or those students 18 years or older, were used in 66% of the SLP studies (e.g., Browder, Hines, McCarthy, & Fees, 1984; Cuvo, Ellis, Wisotzek, Davis, Schilling, & Bechtal, 1983; Greer, Becker, Saxe, & Mirabella, 1985; Horner, Wuerch, & Boomer, 1981; Richman, Reiss, Bauman, & Bailey, 1984).

The handicapping conditions of the students included diagnoses of mild or borderline (e.g., Martin, Cornick, Hughes, Mullen, & Ducharme, 1984; Wehman, Hill, & Koehler, 1979), moderate (e.g., Cronin & Cuvo, 1979; Kohl, Wilcox, & Karlan, 1978), and severe and profound mental retardation (e.g., Bates & Renzaglia, 1982; Friedenberg & Martin, 1977; Janssen & Guess, 1978; Mithaug, 1978).

Behaviors

The behaviors selected for training varied across studies. Although SLP is a versatile procedure used to teach a variety of discrete and chained tasks (Wolery & Gast, 1984), approximately 67% of the studies reported teaching chained behaviors. The types of chained behaviors varied across domains including leisure skills (e.g., Breen, Haring, Pitts-Conway, & Gaylord-Ross, 1985; Duffy & Nietupski, 1985; Marchant & Wehman, 1979), community skills (e.g., Aeschleman & Schladenhauffen, 1984; Coon, Vogelsberg, & Williams, 1981; Sowers, Rusch, & Hudson, 1979), self care skills (e.g., Azrin, Schaeffer, & Wesolowski, 1976; Freagon & Rotatori, 1982; Kissel, Johnson, & Whitman, 1980), daily living skills (e.g., Cronin & Cuvo, 1979; Thompson, Braam, & Fuqua, 1982; Williams & Cuvo, 1986), and vocational skills (e.g., Alper, 1985; Spooner & Hendrickson, 1976; Walls, Sienicki, & Crist, 1981). This diversity is also true of discrete skills. These include expressive language skills (e.g., Duker & Moonan, 1985; Kohl, 1981; Konstantares, 1984) and receptive language and academic behaviors (e.g., Koller & Mulhern, 1977; Mithaug, 1978; Rynders, Behlen, & Horrobin, 1979).

Prompt Hierarchy

Number of Prompt Levels

The number of levels found in the studies ranged from three to six. For purposes of this review, the first level in the hierarchy was defined as the presentation of the discriminative stimulus alone, and was referred to as the natural cue (Wolery & Gast, 1984), no help level (Cronin & Cuvo, 1979), the no assistance level (Spears, Rusch, York, & Lilly, 1981), and the instruction only level (O'Brien & Azrin, 1972). The term independent has been used in Table 3 to designate Level 1 when not otherwise labeled by the author.

The majority of studies (60%) defined four levels of prompts for teaching a variety of skills such as cleaning restrooms (Cuvo et al., 1978), manual sign production (Duker & Michielson, 1983), toothbrushing (Horner & Keilitz, 1975), grocery purchasing (McDonnell, Horner, & Williams, 1984), and soap dispensor use (Pancsofar & Bates, 1985). Of the remaining studies, 12% specify three prompt levels, for example, domestic skills (Livi & Ford, 1985), appropriate mealtime behavior (O'Brien & Azrin, 1972), and cooking skills

(Schleien, Ash, Kierman, & Wehman, 1981). In 16% of the studies, a five prompt hierarchy was used, for example, leisure game playing (Nietupski & Svoboda, 1982), independent movement (Walker & Vogelsberg, 1985), and apartment maintenance (Williams & Cuvo, 1986). Halasz-Dees and Cuvo (1986) provided 6 levels of prompts in teaching a leisure skill activity.

As seen in Table 3, there is no correlation between the choice in number of prompt levels and behaviors taught. However, studies teaching discrete tasks tended to use fewer levels. For example, 75% of the studies using a 3 prompt level hierarchy, trained a discrete task rather than a chained task.

Prompt Types

Cuvo and Davis (1983) classify and provide definitions for the types of instructional prompts found in the SLP hierarchy: 1) verbal instructions, 2) visual cues, 3) modeling, and 4) physical prompts. This division of prompts has also been described as the "tell, show, and touch or physical guidance" procedure by Sulzer-Azaroff and Mayer (1977).

Verbal instructions, as described by Cuvo and Davis, occur in question form as an indirect verbal cue (e.g. "What's next?" Cuvo et al., 1981; Nietupski & Svoboda, 1982) or as a direct verbal description of the specific behavior to be performed by the student (e.g. "Go make coffee." Breen et al., 1985).

As seen in Table 3, a verbal instruction is typically used at the independent level as the discriminative stimulus. This verbal S^D may be simultaneously presented with each succeedingly more intrusive prompt (e.g., in 16% of the studies). However, if the initial S^D is simply the opportunity to respond to another natural cue, the first prompt level will generally include a verbal description or suggestion of the correct behavior (cf. Correa et al., 1984; Horner & Keilitz, 1975). A majority (65%) of the studies used verbal instructions to provide additional information in the SLP hierarchy.

Cuvo and Davis (1983) suggest that the use of verbal prompts in a majority of the studies may be due to the assumed lack of intrusiveness, the relative ease with which it can be delivered and faded by the trainer, and its occurrence in the natural environment.

Cuvo and Davis called the second type of instructional prompt a visual cue. These prompts may form a completed or partial visual representation of a target response, for example, Cronin and Cuvo (1979) marked the stitch length in the hem of a garment with tailor chalk, and Halasz-Dees and Cuvo (1986) provided a finished macrame knot. Another effective visual prompt is a gesture, such as pointing to an object in a manual sign production study (Duker & Moonan 1985) or pointing to a task step in a leisure skills activity (Hamre-Nietupski et al., 1984). As seen in Table 3, 24% of the prompt sequences use a gesture as a prompt in the SLP hierarchy. When a visual prompt is used it generally occurs at the second prompt level.

The third type of instructional prompt is modeling or direct demonstration of the correct response by the trainer. Examples of modeling in the SLP studies included demonstration of a correct step in a domestic skill (Smith & Belcher 1985) and leisure skill (Wehman, Renzaglia, Berry, Schutz, & Karan 1978). A large percentage of the studies (e.g., 70%) reported the use of a model cue in the prompt hierarchy and 12% report the use of two or more models in the sequence.

The final type of instructional prompt is a physical prompt. This prompt is generally assumed to be the most intrusive level and to provide the greatest amount of information to the student. The physical prompt was presented in a variety of forms in the literature, e.g., hand over hand guidance in reaching and grasping (Correa et al., 1984) and handshape of correct math computations (Koller & Mulhern 1977). In 19% of the studies, partial physical guidance was a specified prompt level, e.g., an orienting prompt (Rae & Roll 1985), touch prompt (Wambold & Salisbury 1978), or as one-third, two-thirds, three-thirds physical guidance (Duker & Michelson 1983). Physical prompts were used in 84% of the studies as the most intrusive prompt in the hierarchy.

As shown in Table 3, the majority (66%) of the studies used the verbal instruction/model/physical guidance sequence in training. However, there are many variations in this sequence, e.g., indirect verbal followed by direct verbal cues and partial physical guidance followed by full or graduated guidance. The addition of prompts to the verbal, model, physical prompt sequence may result in increasing training time but it also may increase the probability of correct prompted responses and reinforcement for the student. Breen et al. (1985) used six levels including an indirect verbal cue at the independent level, an additional indirect cue at the second level, followed by a direct verbal cue, gesture, partial physical guidance, and full physical guidance. In training basic photography skills, Giangreco (1983) used five prompt levels: verbal task instruction, verbal prompt, gesture, model, and physical guidance. No direct correlation was found between the sequence or types of prompts and the target behaviors.

Prompt Interval

Wolery and Gast (1984) suggest that the third critical feature of SLP should be the inclusion of a constant response interval following each prompt level in the hierarchy. Based on information provided by the authors, the time interval was not specified in 53% of the studies (e.g., Freagon & Rotatori, 1982; Hupp & Mervis, 1981; Lagomarcino et al., 1984). Included in this percentage are those studies which stated a response interval occurred but did not report the specific time, e.g., "few seconds" (Azrin et al., 1976), "waits" (Stainback et al., 1983), "all prompt levels followed by the opportunity to respond independently" (Wacker et al., 1980 p. 288). In addition, a few authors referenced previous works which have specified the interval but did not define it in their studies, for example, Coon et al.

(1981) referenced Vogelsberg (1979) and Schleien et al. (1981); Schleien, Certo, and Muccino (1984) and Schleien and Larson (1986) referenced Horner and Keilitz (1975).

Of the studies reporting a specific interval, a large percentage (48%) define 5-sec as the response interval including Horner and Keilitz (1975) and Vogelsberg (1979). A 10-sec interval was specified in 24% of the studies (e.g., Alper, 1985; Correa et al., 1984; Rosenbaum & Breiling, 1976) and 14% stated that 3-sec interval was used (e.g., Breen et al., 1985; Spears et al., 1981; Wilson et al., 1984). The remaining studies reported a varied number of seconds ranging from 2 to 30-sec. This information is included in Table 3.

Consequences

Correct Responses

Based upon review and instructional model descriptions articles specific to SLP (e.g., Alberto & Schofield, 1979; Billingsley & Romer, 1983; Falvey et al., 1980; Schoen, 1986; Wolery & Gast, 1984; York, Williams, & Brown, 1976), positive reinforcement should follow correct responses at each prompt level. However, this information is reported in only 48% of the studies reviewed. Specific statements varied from study to study indicating that this had occurred (e.g., "after each correct response, regardless of the level of assistance" Freagon & Rotatori, 1982, p. 74). Browder et al. (1984) reinforced "equivalent correct responses" and those which occurred following delivery of less intrusive prompts. Haring (1985) and Janssen and Guess (1978) reinforced correct responding throughout the hierarchy except at the final physical guidance level. Marchetti, Cecil, Graves, and Marchetti (1984) and Matson, Marchetti, and Adkins (1980) reinforced correct responses at the independent level only, or following a prompted sequences of responses.

Movement from one prompt level to another following correct responding usually resulted in a return to the independent level on the next trial (e.g., Noonan, 1984; O'Brien & Azrin, 1972; Van den Pol, Iwata, Page, Neef, &

Whitley, 1981). This decision was also based on trainer discretion, population, and behavior trained (e.g., O'Brien, 1978, reinforced at all prompt levels but followed with next trial presentation at the preceding less intrusive level).

Incorrect Responses

In SLP the consequences for errors or no responses at any level in the hierarchy resulted in proceeding to the next most intrusive prompt level. This occurred in 93% of the studies reviewed. Variations included differentiating between errors and no responses; for example, Duker and Michielson (1983) presented the next most intrusive prompt contingent upon no responding and verbal reprimand ("no") paired with full physical guidance for errors; Spooner and Hendrickson (1976) presented the next prompt for no responding and hand over hand guidance for errors. In addition, some trainers paired additional correction procedures with presentation of the next prompt; for example, Giangreco (1983) interrupted errors, pointed out the original S^D and immediately presented the next most intrusive prompt; Kissel et al. (1980) presented a 5-sec period of extinction followed by the next prompt level. Very few of the studies described procedures used as consequences for errors at the final prompt level. Horner and Keilitz (1975) and Tucker and Berry (1980) state that resistance to physical guidance at the last level in the hierarchy resulted in the next trial being presented at the "no help" level. As seen in Table 3, 45% of the authors either describe their use of SLP as an error correction procedure or this can be infered from their differential consequation of no responding and errors (e.g. Duffy et al., 1985; Friendenberg & Martin, 1977; Hamre-Nietupski et al., 1984; Nietupski et al., 1983).

Results

Effectiveness

All of the studies selected as SLP reported effectiveness data. In 85% of the studies the behaviors were taught to criterion. The remaining studies either (a) demonstrated improvement over baseline rates (e.g., Correa et al., 1984, improved the reach and grasp performance of 3 severe and profound preschoolers over initial levels), (b) reached criterion for some students but not all (e.g., Horner & Keilitz, 1975, taught toothbrushing to six students but one left the study and the final student did not meet criterion), or (c) the authors did not train to criterion (e.g., Hupp et al., 1986, conducted 15 days of training in receptive identification of pictures and expressive sign production).

Although the majority of studies reported data demonstrating the effectiveness of SLP as an instructional strategy, 26% of the studies manipulated an instructional variable resulting in some comparative data. These variables included environmental manipulation (e.g., training in the artificial versus natural environments, Freagon & Rotatori, 1982; group versus individual training, Kohl et al., 1978), material manipulation (e.g., hand compared to machine stapling, Friedenberg & Martin, 1977), and stimulus variation manipulation (e.g. presentation of label S^D only versus label and function S^D, Janssen & Guess, 1978). In all of the parametric studies SLP was the only strategy used.

Efficiency

Efficiency data such as total training time, number of sessions, number of trials to criterion, errors and/or number of prompts needed at each level were reported in 53% of the studies. The most frequently reported efficiency data were total training time or number of sessions to criterion (e.g., Bellamy & Buttars, 1975; Cuvo et al., 1978; Giangreco, 1983). The number of prompts delivered at each level was reported in anecdotal form, e.g., the number of prompts decreased over tasks (Cronin & Cuvo, 1979) and in more specific form, e.g., total number of prompts for two experiments delivered at each level (Cuvo et al., 1983). Rosenbaum and Breiling (1976) also reported that less training time was needed as students met criterion on reading comprehension skills.

Summary

Based upon the literature reviewed, the following statements can be made:

* There was no consensus among authors as to the term used to label this instructional strategy.

* The population trained in SLP studies demonstrated a wide range of variance in both chronological age and handicapping conditions, with no correlation between population selected and effectiveness of the procedure.

* The strategy was used to teach a wide range of behaviors both chained and discrete, from all curricular domains. There was no correlation between the behavior selected for training and the effectiveness of SLP in establishing acquisition of that behavior.

* Wolery and Gast's (1984) first guideline, presenting the independent S^D at each prompt level throughout the hierarchy, occurred in very few of the studies (i.e, 14%) as defined in the method sections of the investigations.

* The number of prompt levels and types of prompts found in SLP varies dependent upon student abilities and characteristics of the natural cue (Wolery & Gast, 1984). Following Wolery and Gasts second guideline, all trainers selected prompts which provided students with increasingly more information contingent upon errors or no responses. The greatest percentage of trainers selected four levels but this varied across domains and populations resulting in no correlation between the number of levels and the effectiveness and efficiency of the procedure. A similar statement can be made regarding the types of prompts selected by the trainers. Although verbal instruction, model, and physical guidance prompts were used with the greatest frequency, a large number of variations in the presentation and configuration of these prompts exists, and those variations may be population, task, and trainer specific.

* The constant response interval, Wolery and Gast's (1984) third guideline (allowing the student a specific amount of time to respond independently), was defined in some studies and implied in others. The specific time was again dependent upon trainer discretion, resulting in a range of interval times of 2-sec to 30-sec. A large percentage of studies did not define this interval.

* The fourth guideline suggested by Wolery and Gast (1984) was the delivery of reinforcement for correct responding at each prompt level; about one-half of the studies included this information.

* Based upon effectiveness data reported in Table 2, SLP was an effective instructional strategy for teaching a wide range of behaviors to students with a variety of handicaps. The lack of specificity regarding the response intervals, reinforcement procedures, consequences for errors, or movement between the prompt intervals, may make replication of studies impossible. However, there was no correlation between lack of this information and the effectiveness of the SLP strategy in training new behaviors.

* Efficiency data were reported inconsistently across studies. Data on errors, responses by prompt level, and responses by prompt type are variables that should be addressed in future research.

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Constant Time Delay

Chapter 7

Patricia Munson Doyle, Mark Wolery, Melinda Jones Ault, and David L. Gast

The constant time delay procedure attempts to transfer stimulus control from a prompt to the designated novel stimulus by systematically varying the interval between the novel discriminative stimulus and presentation of the predetermined controlling prompt. The initial trial or block of trials begins with the simultaneous presentation of the novel stimulus and the prompt (i.e., 0-sec delay). Following this simultaneous presentation, the interval increases to a fixed delay (e.g., 4-sec) and is unchanged for the remaining instructional trials. The constant time delay procedure is different from the progressive delay procedure in that the progressive procedure involves gradual increases in the delay interval.

Reviews of the constant time delay strategy, procedural descriptions, differences from other instructional strategies, and suggestions for future use can be found in Billingsley and Romer (1983), Schoen (1986), Snell and Gast (1981), Touchette (1971), and Wolery and Gast (1984). Constant time delay has been referred to in the literature as "time delay" (Browder, Morris, & Snell, 1981; Touchette, 1971), "modified delay cue procedure" (Mcllvane, Withstandley, & Stoddard, 1984), "Touchette's 4-sec delay procedure" (Johnson, 1977), and most frequently as "constant time delay" (Kleinert & Gast, 1982; Snell & Gast, 1981). For purposes of consistency and description, this chapter uses "constant time delay" (CTD).

The CTD trial sequence is shown in Figure 1 and consists of the trainer presenting the stimulus, waiting the specified fixed delay interval, followed

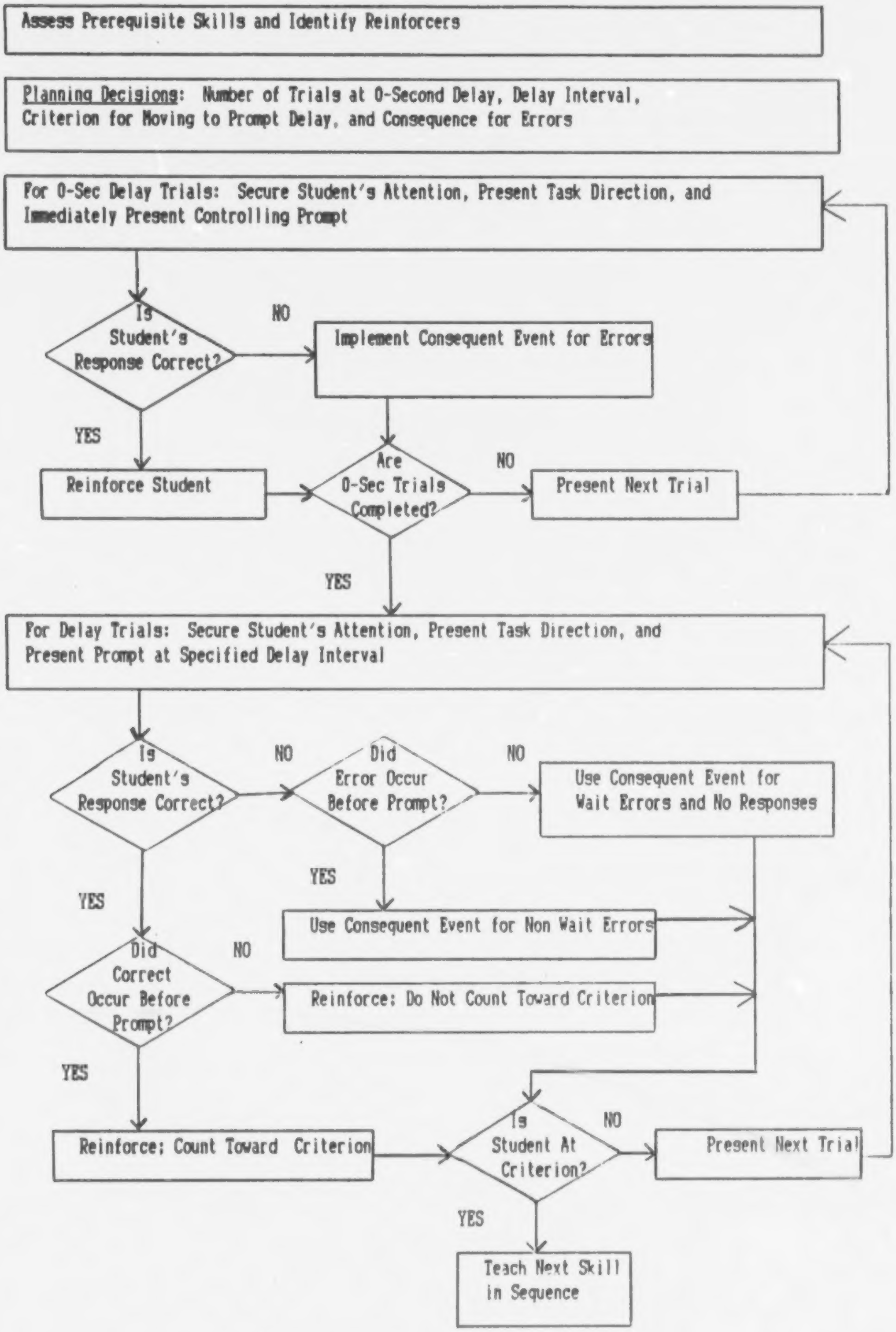
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Number of Trials at 0-Second Delay, Delay Interval, Criterion for Moving to Prompt Delay, and Consequence for Errors
For 0-Sec Delay Trials: Secure Student's Attention, Present Task Direction, and Immediately Present Controlling Prompt
Is Student's Response Correct?
NO
Implement Consequent Event for Errors
YES
Reinforce Student
Are 0-Sec Trials Completed?
NO
Present Next Trial
YES
For Delay Trials: Secure Student's Attention, Present Task Direction, and Present Prompt at Specified Delay Interval
Is Student's Response Correct?
NO
Did Error Occur Before Prompt?
NO
Use Consequent Event for Wait Errors and No Responses
YES
YES
Use Consequent Event for Non Wait Errors
Did Correct Occur Before Prompt?
NO
Reinforce: Do Not Count Toward Criterion
YES
Reinforce; Count Toward Criterion
Is Student At Criterion?
NO
Present Next Trial
YES
Teach Next Skill in Sequence

Figure 7.1 Flow chart depicting the constant time delay strategy.

by presentation of the controlling prompt. The students are reinforced for correct responding prior to and following delivery of the prompt by the trainer. Consequences for errors are delivered contingent upon the student responding incorrectly prior to the trainer presentation of the prompt, and responding incorrectly or not responding after the delivery of the prompt. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using the CTD strategy are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

Table 1

Results from Investigations Using the Constant Time Delay Strategy

Citation	Population Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
Browder et al. (1981)	1M	14	SMR	IN	Manual sign	+	E	N/D	+/- W	MB
Johnson (1977)	1M	17	MH	PS	Recep i.d. of symbols	+	S E	N/D	N/D	N/D
Kleinert & Gast (1982)	1M	31	MH	CS	Manual sign	+	T M E	+ T S	N/D	MP
McIlvane et al. (1984)	4M	7-27	SMR PMR Aut	IN	Visual to visual match	+	S	N/D	N/D	N/D

Table 2

Methods from Investigations Using the Constant Time Delay Strategy

Citation	Population		Behavior		Controlling	Delay Interval/Fading Rules		Consequences	
	Number/Diagnosis		Name	Type	Prompt			Correct Responses	Error Responses
Browder et al. (1981)	1	SMR	Manual sign	DS	MO Handshape	0 - 4 sec. 8 sec.	4 correct partic. responses increase 4 sec.	food; diff. reinf. improved performance	VR Handshape
Johnson (1977)	1	MH	Recep. i.d of symbols	DS	MO	pretrain 0, 1,... 4 sec. training 4 sec.	increase delay when correct antic. at 4 sec in pretrain. Train at 4 sec. delay	tokens/ praise	30- sec. extinction
Kleinert & Gast (1982)	1	MH	Manual sign	DS	MO	0-4 sec.	When 10 trials at 0-sec. increase to 4 sec. delay	Descriptive verbal praise	VR Remove materials 10 sec. time out
McIlvane et. al. (1984)	4	SMR PMR Aut	Visual to visual match	DS	Red Light Cue, Visual sample	0-4 sec.	A "Later trials"	Food	Lower Screen diff. reinf.
CODES	See Appendix A		See Appendix A Ch = chained DS = discrete		MO = model VI = verbal instruction FP = full physical manipulation	N/D = not defined A = anecdotal narrative N/A = not applicable		CRF = continuous reinforcement FR = fixed ratio reinforcement VR = variable ratio reinforcement N/D - not defined	N/D = not defined VR = verbal reprimand VI = verbal instruction MO = model FP = full physical manipulation

Behaviors/Population

Based upon the published literature, four studies were identified as using CTD, (Browder et al., 1981; Johnson, 1977; Kleinert & Gast, 1982; Mcllvane et al., 1984). These four studies implemented CTD with students who were elementary age (Mcllvane et al., 1984), adolescents, (Browder et al., 1981; Johnson, 1977), and adults (Kleinert & Gast, 1982; Mcllvane et al., 1984). The students had multiple handicaps, and moderate or severe retardation. All subjects were males.

The studies which implemented CTD taught a variety of discrete language or language related academic skills. Johnson (1977) taught receptive language identification and simple flashcard addition problems in intermix (i.e., two or more behaviors taught simultaneously to criterion). Kleinert and Gast (1982) and Browder et al. (1981) taught expressive sign acquisition in isolation (i.e., one behavior taught to criterion prior to introduction of a second behavior); and Mcllvane et al., (1984) taught a matching to sample task in intermix using a modified time delay procedure. No chained tasks were taught using the CTD strategy.

Controlling Prompt

Following the decision to use CTD, the teacher should select an appropriate controlling prompt. Prompt selection is dependent upon the students' skills and the behaviors to be taught. For example, if the behavior to be taught is an expressive response and the student is vocally imitative, the teacher would select an auditory cue (e.g., vocal model) as the controlling prompt; if the task to be acquired is receptive and the student was motorically imitative, the teacher would select a gestural model (e.g., a point or touch behavior).

Johnson (1977) taught receptive identification of animal pictures, geometric shapes, and simple addition problems. The controlling prompt was the experimenter pointing to the correct picture. Kleinert and Gast (1982) taught manual expressive labeling of photographs of actual people, places, or objects in the student's environment; a model of the correct manual sign was the controlling prompt. Browder et al. (1984) transferred control across two levels of controlling prompts in teaching expressive sign production. In the initial phase of this study, the controlling prompt was a physical handshape of the correct sign; in the second phase, a model of the correct sign was the controlling prompt. Mcllvane et al. (1984) used a visual red light cue paired with a food item in order to teach a matching to sample task with one pair of subjects and used a model with two younger students.

Delay Interval

Initially in the CTD procedure, the controlling prompt is presented simultaneously with the discriminative stimulus (i.e., 0-sec delay). On subsequent trials, the interval between the stimulus and the prompt is increased by a constant amount of time (e.g., 4-sec). Snell and Gast (1981) refer to the CTD procedure as a modification of the Touchette (1971) delay strategy. Touchette (1974) first described the use of a constant interval between presentation of the discriminative stimulus and controlling prompt and employed an interval of 4 seconds. Johnson (1977), Browder et al. (1981), Kleinert and Gast (1982), and Mcllvane et al. (1984) all used a 4-sec delay interval.

Movement Through Prompt Levels

The movement from the 0-sec delay to the final delay interval may occur after a trial or a block of trials. This is a decision that should occur prior to using the procedure, and investigators differ in their decisions. Touchette (1971) increased the interval following completion of one trial while Kleinert and Gast (1982) increased the delay interval following a block of 10 trials. Mcllvane et al. (1984) state that the initial delay was at 0-sec but on later trials the cue was delayed for approximately 4 sec after sample presentation. Johnson (1977), prior to training receptive identification behaviors, implemented a pretraining session to establish a waiting response. The student was differentially reinforced for waiting after an S^D for the delivery of the controlling prompt during an impossible discrimination task. This was done by gradually increasing the delay interval by 1-sec increments. After the student learned to wait 4 sec, training began with a fixed delay of 4 seconds.

Browder et al. (1981) transferred control across two levels of controlling prompts. Criterion for movement was based on both a given number of trials and performance. In the initial phase at 0-sec delay, the controlling prompt, a handshape, was simultaneously presented with an imitative discriminative stimulus. Criterion for movement was 3 trials at 0-sec delay followed by Phase II, which paired a model controlling prompt with the same imitative stimulus and the handshape prompt occurring at a fixed interval of 4-seconds. The second prompt (handshape) was delivered contingent upon the student emitting no response after delivery of the less intrusive model prompt. Criterion for movement of the delay intervals of both the model and handshape prompts in later phases was 4 consecutive correct responses to the task stimulus, followed by the delay intervals increasing to 4 and 8 sec, respectively.

Consequences

Correct Responses

In the CTD procedure, the student may respond correctly at various points in the trial sequence. For example, a correct response could occur following presentation of the natural discriminative stimulus and prior to delivery of the controlling prompt. Johnson (1977), Snell and Gast (1981), Kleinert and Gast (1982), define and identify this response as a correct anticipation; Browder et al. (1981) label it as an unprompted correct response. An additional correct response may occur following delivery of the controlling prompt. Snell and Gast (1981), Kleinert and Gast (1982), and Johnson (1977) identify this response as a correct wait; Browder et al. (1981) call it a prompted response. Both of the above correct responses may result in delivery of reinforcement; tokens and praise (Johnson, 1977) or an edible reinforcement (Mcllvane et al., 1984; Browder et al., 1981). Only those correct responses occurring prior to the trainers' prompt counted toward criterion. To encourage increases in correct unprompted correct responses and the transfer of stimulus control, Browder et al. (1981) manipulated the reinforcement contingencies in later phases of training as the signed training stimulus (e.g., food) was delivered only after the student emitted a correct unprompted response.

Error Responses

Snell and Gast (1981) and Kleinert and Gast (1982) describe three types of student errors that may occur in the CTD trial sequence: non wait errors (incorrect responses before presentation of the controlling prompt), wait errors (incorrect responses after presentation of the controlling prompt), or no responses. Johnson (1977) and Browder et al. (1981) identify and record errors as simply incorrect. Investigators differ as to their use of consequences for errors emitted during training. Johnson (1977) placed incorrects on extinction (ignored the student for a duration of 30 sec). Kleinert and Gast (1982) delivered a mild verbal punisher, "No," removed the stimulus, ignored the student for a duration of 10-sec, and then proceeded to the next training trial. Browder et al. (1981) provided a handshape of the correct sign contingent upon incorrect student responses.

Results

Effectiveness

Based upon results reported in the four studies, CTD was effective in establishing the transfer of stimulus control to the discriminative stimulus. Johnson (1977) stated the students' correct anticipations ranged in training 57-86%, 16-94%, and 3-93% in training groups 1, 2, and 3, respectively. Browder et al. (1981) reported the student met criterion (i.e., 4 trials of correct responses) on all 5 signs selected for training. Kleinert and Gast (1982) reported that CTD was effective in teaching the six selected signs to the student at 100% criterion. Mcllvane et al. (1984) stated that all 4 students met criterion of 100% correct responses.

Efficiency

Efficiency data such as number of trials, number of sessions, total training time, and number/percent of errors to criterion is presented in various forms by the authors of the CTD studies. Kleinert and Gast (1982) reported data for each sign taught in addition to the total number of trials, training time, and number of errors to criterion. Mcllvane et al. (1982) reported that both adults and one child student met the criterion in one session, while the second child met the criterion of 100% in 8 sessions. Browder et al. (1981) reported the percentage of errors performed during teaching, review, and baseline. In the Johnson (1977) study, the students' wait response was acquired in one 10 minute pretraining session. Sessions and errors to criterion were reported.

Summary

Based on the reviewed literature, the following statements can be made:

- * The population used in CTD studies demonstrated a wide range of variance in both chronological age and handicapping conditions.
- * All of the studies reported teaching discrete behaviors; no examples of CTD being used to teach chained tasks were found.
- * The use of a variety of controlling prompts reflected the dependency of prompt selection on population, behaviors being trained, and teacher discretion.
- * Initial acquisition of training items occurred in isolation and intermix sessions. However, in those studies using isolation, student responding in intermix was an integral part of the final performance criterion.
- * All studies selected a delay interval of 4-sec; however, this could be described as an arbitrary decision based upon successful demonstration of its use in applied settings (e.g., Touchette, 1974 reported the original "four second delay").
- * The criterion for movement from the 0-sec to the 4-sec delay interval was dependent upon number of trials presented and/or student performance.
- * The majority of authors in the review articles and investigations provided positive reinforcement for correct responses prior to the occurrence of the controlling prompt (i.e., correct anticipations) and following delivery of the prompt (i.e., correct waits).
- * Consequences for incorrect responses were delivered contingent upon student errors: prior to prompt delivery (i.e., non-wait error), following presentation of the prompt (i.e., wait error), or failure to emit any response (i.e., no response). The consequences for student errors varied across studies; however, a short period of extinction or limited timeout has been suggested as an effective consequence in the time delay procedure.
- * All of the studies reported that CTD was effective in training the targeted behaviors.
- * All of the studies reported efficiency data in the form of trials to criterion, sessions to criterion, total training time, and/or total number of errors.

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Progressive Time Delay

Chapter 8

Melinda Jones Ault, Mark Wolery, Patricia Munson Doyle, and David L. Gast

The progressive time delay procedure (PTD) involves the transfer of stimulus control from a controlling prompt to a novel stimulus. It consists of gradually fading the controlling prompt by increasing the interval between the presentation of the stimulus and the delivery of the controlling response prompt (Snell & Gast, 1981; Touchette, 1971). Initially, the stimulus and the controlling prompt are presented simultaneously for a trial or block of trials. Based on participant responding or a fixed number of trials, the interval between presentation of the stimulus and the prompt is gradually increased in small increments (e.g. by 0.5 sec, 1-sec, or 2-sec increments). The behavior is considered mastered when the participant can consistently respond to the novel stimulus before the experimenter provides the prompt.

The PTD trial sequence is shown in Figure 1 and consists of the experimenter presenting the stimulus, waiting the specified delay interval and then providing the controlling prompt. Participants are reinforced for responding correctly before or after the experimenter provides the prompt. Consequences are delivered for responding incorrectly before the experimenter delivers the prompt, responding incorrectly after the experimenter delivers the prompt, or not responding following the prompt. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using the progressive time delay procedure are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

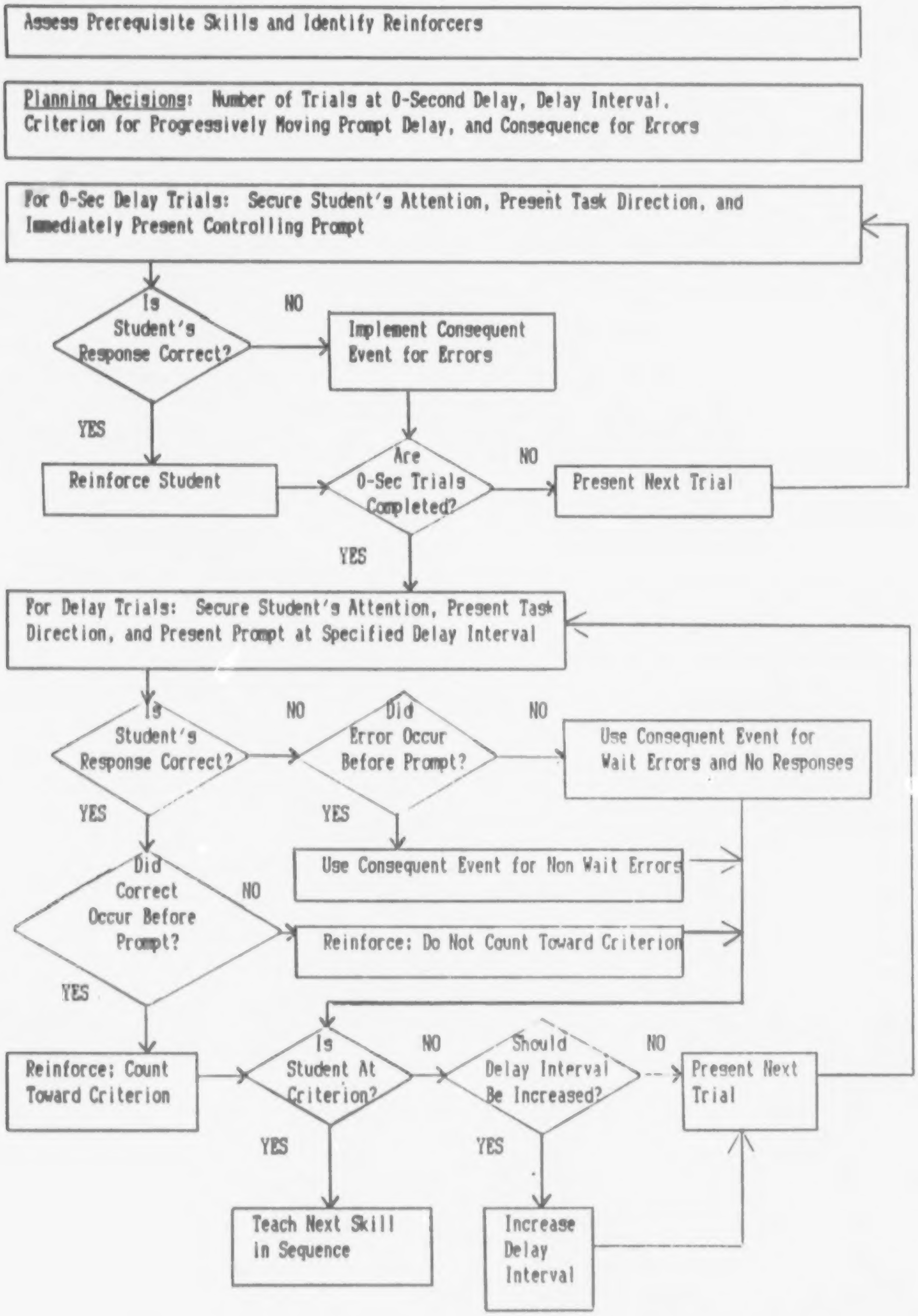
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Number of Trials at 0-Second Delay, Delay Interval, Criterion for Progressively Moving Prompt Delay, and Consequence for Errors
For 0-Sec Delay Trials: Secure Student's Attention, Present Task Direction, and Immediately Present Controlling Prompt
Is Student's Response Correct?
NO
Implement Consequent Event for Errors
YES
Reinforce Student
Are 0-Sec Trials Completed?
NO
Present Next Trial
YES
For Delay Trials: Secure Student's Attention, Present Task Direction, and Present Prompt at Specified Delay Interval
Is Student's Response Correct?
NO
Did Error Occur Before Prompt?
NO
Use Consequent Event for Wait Errors and No Responses
YES
YES
Use Consequent Event for Non Wait Errors
Did Correct Occur Before Prompt?
NO
Reinforce: Do Not Count Toward Criterion
YES
Reinforce: Count Toward Criterion
Is Student At Criterion?
NO
Should Delay Interval Be Increased?
NO
Present Next Trial
YES
YES
Teach Next Skill in Sequence
Increase Delay Interval

Figure 8.1 Flow chart depicting the progressive time delay strategy.

Table 1

Results from Investigations Using the Progressive Time Delay Strategy

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs	Diagnosis							
Aeschleman & Schladenhauffen (1984)	3M 1F	17-18	SMR	IN	Mnemonic training	+	N/D	N/D	N/D	MP
Barrera & Sulzer-Azaroff (1983)	3F	6-9	Aut	IN	Express. id. of objects	V1+ V2+/-	T V1<V2	N/D	N/D	AT
Variable 1 - Total communication training; Variable 2 - Oral alone training										
Braam & Poling (1983) Exp.II	1M	17	MoMR SLI	PS	Intraverbal behavior	+	E S	N/D	+/-D	MP
Browder et al. (1984)	8N/D	24-43	MiMR MoMR SMR	IN	Word Reading	+	N/D	T+	N/D	MP
Charlop et al. (1985)	7M	5.1-11.5	Aut	PS	Verbal Mands	6 Subj.+ 1 Subj.+/m	T	S+ P,S+/- T+/-	N/D	MB
Goetz et al. (1983)	1M	14	MH VI	PS	Head turn to sound	+	T	N/D	N/D	A-B
Luciano (1986)	2F	15-16	DD	H	Intraverbal behavior	+	E	T+	+/-M	MP
McDonagh et al. (1984) Exp I	1F	28	MoMR	IN	Match printed price to coins	+	E	T+	N/D	PP
McIlvane et al. (1984) Exp II	1M	27	SMR	IN	Match manual sign to food	N/D	N/D	N/D	N/D	N/D
Smeets & Striefel (1976)	1F	14	MH VI HI	IN	Recept./Express. id. of pictures	+	N/D	TV1+ TV2+/-	N/D	MB
Variable 1 - expressive training; Variable 2 - receptive training										
Smeets & Striefel (1980)	2M 1F	13-16	PMR	CS	Instruction following	2 Subj.+ 1 Subj.+/m	E	P+ P,S+/-	+/-W	MB

Table 1 Continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age Yrs	Diagnosis							
Snell (1982)	4M	17- 21	SMR	IN	Bedmaking	3+ 1+/-m	E S M T	S,T+/-	+/-W	MP
Striefel et al. (1974)	2M 1F	11- 15	PMR	IN	Instruction following	+	E	T-	N/D	MB
Touchette & Howard (1984)	2M 1F	6- 13	SMR	SS	Recept. visual discrimination	+	T V2<V1;V3	T+/-	N/D	AT
Variable 1 - CRF/CRF; Variable 2 - CRF/VR3; Variable 3 - FR3/CRF										
Walls et al. (1982)	12M 8F	17- 60	SMR MoMR MiMR	CS	Assembly of apparatus	N/A	EV1<V2;V3 MV1<V2;V3	N/D	N/D	Gr
Variable 1 - 1 sec. delay; Variable 2 - 3 sec. delay; Variable 3-5 sec. delay										
Zane et al. (1984)	2M 2F	29- 53	SMR	CS	Recept.id. of symbols	2 Subjects V1>V2 1 Subject V2>V1	M V1=V2	N/D	2 Subj. V1>V2 1 Subj. V2>V1	AT MB
Variable 1 - PTD; Variable 2 - Intervening response										

Table 2

Methods from Investigations Using the Progressive Time Delay Strategy

Citation	Population		Behavior		Controlling	Delay Interval/	Consequences	
	Number/	Diagnosis	Name	Type	Prompt	Fading Rules	Correct Responses	Error Responses
Aeschleman & Schladenhauffen (1984)	4	SMR	Mnemonic Training	DS	MO	N/D, A	descriptive praise	N/D
Barrera & Sulzer-Azaroff (1983)	3	Aut	Express. id. of objects	DS	MO	N/D	social praise; edibles	15-sec. in-seat time-out
Braam & Poling (1983)	1	MoMR SLI	Intraverbal Behavior	DS	Visual prompt	1 sec. increase each 15 antic.: Maximum 2 sec.	antic.-desc. praise + token FR1 wait-desc. praise FR1; token FR3	repeat trial
Browder et al. (1984)	8	MoMR	Word Reading	DS	MO	2 sec. increase each session; Maximum 8 sec.	antic.-2 pennies waits-1 penny	VR VI
Charlop et al. (1985)	7	Aut	Verbal mands	DS	MO	2 sec. increase each 3 antic/waits; Maximum 10 sec.	gave subject object requested	VR; removed stimulus
Goetz et al. (1983)	1	MH VI	Head turn to sound	DS	Illumination of light	2 sec. increase each 90% corrects for 2/3 days	N/D	N/D
Luciano (1986)	2	DD	Intraverbal behavior	DS	Visual prompt	1 sec. increase after 3 corrects at 0 sec. delay; other increase N/D	praise FR1; token VR3	5 sec. in-seat timeout
McDonagh et al. (1984)								
Exp. 1	1	MoMR	Match printed price to cans	DS	Visual prompt	N/A, A	praise token CRF	No token
CODES	See Appendix A		See Appendix A Ch = chained DS = discrete		MO = model VI = verbal instruction FP = full physical	N/D = not defined A = anecdotal narrative N/A = not applicable	CRF = continuous reinforcement FR = fixed ratio reinforcement VR = variable ratio N/D = not defined	N/D = not defined VR = verbal reprimand VI = verbal instruction MO = model FP = full physical

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Controlling Prompt	Delay Interval/ Fading Rules	Consequences Correct Responses	Error Responses
McIlvane et al. (1984)	1	SMR	Match manual sign to food	DS	MO	N/D, A	praise token	N/D
Smeets & Striefel (1976)	1	MH VI HI	Recept./ Expres. id. of pictures	DS	MO	1 sec. increase each correct	N/D	VR, MO, FP if needed
Smeets & Striefel (1980)	3	PMR	Instruction following	DS	Loud tone instruction	1 sec. increase each correct; Maximum 10 sec.	verbal praise	VR, repeat instruction, FP
Snell (1982)	4	SMR	Bedmaking	Ch	VI, FP initially; then VI, MO	2 sec. increase 1st; 1 sec. thereafter each 4 trials; Maximum 8 sec.	praise + penny FR	VR, FP, 10 sec. timeout
Striefel et al. (1974)	3	PMR	Instruction following	DS	MO	.5 sec. increase 1st; 1 sec. thereafter each correct	N/D	VR, repeat instruction, MO FP
Touchette & Howard (1984)	3	SMR	Recept. visual discrimination	DS	MO	.5 sec. increase each 4 corrects; Maximum 5 sec. or 8 sec.	V1 - antic./waits, token CRF V2 - antic.-token CRF, waits-token FR3 V3 - antic.-token FR3, waits-token CRF	VR, 10 sec. timeout
Walls et al. (1982)	20	MiMR MoMR SMR	Assembly of apparatuses	Ch	MO	V1 - 1 sec. increase each correct V2 - 3 sec. increase each correct V3 - 5 sec. increase each correct	praise	MO
Zane et al. (1984)	4	SMR	Recept. id. of symbols	DS	MO	1 sec. increase after wait/antic.; Maximum 4 sec.	praise	VR, 10 sec. in-seat timeout

Names of Procedure

The PTD procedure has been referred to in the literature as the delayed cue procedure (Aeschleman & Schladenhauffen, 1984; McDonagh, McIlvane, & Stoddard, 1984), delayed prompting procedure (Braam & Poling, 1983; Touchette & Howard, 1984), prompt delay (Luciano, 1986), anticipation procedure (Barrera & Sulzer-Azaroff, 1983), delay procedure (Touchette, 1971; Walls, Haught & Dowler, 1982), stimulus delay (Zane, Handen, Mason, & Geffin, 1984), transfer of stimulus control procedure (Smeets & Striefel, 1976; Striefel, Bryan, & Aikins, 1974), and most frequently as time delay (Browder, Hines, McCarthy, & Fees, 1984; Charlop, Schreibman, & Thibodeau, 1985; Goetz, Gee & Sailor, 1983; Smeets & Striefel, 1980; Snell, 1982; Snell & Gast, 1981).

Behavior/Population

The PTD procedure has been used to teach language-related skills (Barrera & Sulzer-Azaroff, 1983; Braam & Poling, 1983; Charlop et al., 1985; Luciano, 1986; McIlvane, Bass, O'Brien, Gerovac, & Stoddard, 1984; Smeets & Striefel, 1976; Smeets & Striefel, 1980; Striefel et al., 1974), visual discriminations (Zane et al.,1984), chained tasks (Snell, 1982; Walls et al., 1982), responses to auditory cues (Goetz et al.,1983) and cognitive skills such as mnemonic training (Aeschleman & Schladnenhauffen, 1984), sight word reading (Browder et al., 1984), and matching prices to coins (McDonagh et al., 1984). The procedure has been used with students who have moderate, severe, and profound handicaps. Of these studies, only Snell (1982) and Walls et al. (1982) taught chained tasks using a delay procedure. Snell (1982) taught bedmaking skills to adolescents with severe retardation, and Walls et al. (1982) taught vocational assembly tasks to adults with handicaps. The remainder of these studies involved a discrete behavior as the focus of the investigation.

Intermix/Isolation Conditions

Isolation instruction refers to studies in which one behavior was taught to criterion before another behavior was introduced; intermix instruction refers to studies which taught two or more behaviors simultaneously to criterion. Nine studies initially taught behaviors in isolation (Aeschleman & Schladenhauffen, 1984; Braam & Poling, 1983; Luciano, 1986; McDonagh et al., 1984; Smeets & Striefel, 1976; Striefel et al., 1974; Touchette & Howard, 1984; Walls et al., 1982; Zane et al., 1984), and seven taught behaviors in an intermix sequence (Barrera & Sulzer-Azaroff, 1983; Browder et al., 1984; Charlop et al., 1985; Goetz et al., 1983; McIlvane et al., 1984; Snell, 1982; Walls et al., 1982).

Controlling Prompt

Prompts which have been used in PTD investigations to control the responses of subjects included modeling, presentation of a visual stimulus, presentation of an auditory stimulus, and physical prompting. Verbal or verbal and sign models of the correct response have been used as the controlling prompt to teach the expressive tasks of reading sight words (Browder et al., 1984), spontaneous verbal manding (Charlop et al., 1985), and picture labeling (Smeets & Striefel, 1976). Physical models such as pointing to the correct card or modeling a response were the controlling prompts in teaching receptive identification of pictures (Smeets & Striefel, 1976), visual discriminations (Touchette & Howard, 1984; Zane et al., 1984), instruction following (Striefel et al., 1974), and vocational assembly tasks (Walls et al., 1982).

The presentation of a sample visual stimulus has been used to teach intraverbal behavior (Braam & Poling, 1983; Luciano, 1986). For example in the Luciano (1986) study, the experimenter presented the task direction (i.e. "Tell me names of foods") and then presented the controlling prompt of holding up a picture of a food. Goetz et al. (1983) also used a visual stimulus to control a head turning behavior. Following the presentation of an auditory cue (i.e. a sounding drum or maraca), the controlling prompt (i.e. a lighted object illuminated from the same side of the subject's body as the auditory cue) was presented.

The intensity of an auditory stimulus was used by Smeets and Striefel (1980) to control the instruction-following behavior of three profoundly retarded adolescents. Verbal instructions were targeted for training with subjects who would comply only when commands were presented in a loud voice tone. The instructions were first presented in a normal tone of voice followed by the same instruction in a loud voice which was the controlling prompt.

Only one of the PTD studies used a physical prompt as the controlling stimulus. Snell (1982) taught bedmaking using a combination of physical, verbal, and model prompts. During the first 4 trials, the trainer gave the task direction, a simultaneous model plus verbal prompt, and then immediately gave a physical plus verbal prompt for each step in the task analysis. On subsequent trials the physical and verbal prompt was faded on a time delay schedule and was used only as error correction after the eighth trial. The author states that the physical prompt was used initially "to guarantee attainment of the required quality" of each response (p. 146).

Delay Intervals

The controlling prompts in these studies were faded by using a variety of delay schedules. All of the studies began training by presenting the controlling prompt simultaneously with the presentation of the novel stimulus (i.e., 0 sec delay). Following this initial presentation, Braam and Poling (1983), Luciano (1986), Smeets and Striefel (1976), Smeets and Striefel (1980), and Zane et al.(1984) increased the delay interval between the presentation of the stimulus and the controlling prompt in 1 sec increments. Browder et al. (1984) and Charlop et al. (1985) increased the presentation of the controlling prompt in 2 sec increments. The Touchette and Howard (1984) study was the only investigation which increased delay intervals in 0.5 sec increments. Three studies did not increase the delay in equal sec increments. Goetz et al. (1983) initially used a 0, 1, 3 sec delay progression and increased the delay by 1 sec thereafter. Snell (1982) increased the delay initially by 2 sec, and then in 1 sec increments for the remainder of the study. Striefel et al. (1974) first increased the delay interval by 0.5 sec followed by 1 sec increments. Walls et al. (1982) was the only study reviewed which compared delay intervals. Intervals which were increased in 1, 3, and 5 sec increments were compared. Results indicated that the 1 sec delay produced fewer errors, had the lowest training time, and had the earliest acquisition of the three intervals.

Some of the studies specified a limit on the delay interval at which point the delay did not increase but remained the same for the remainder of the study (Braam & Poling, 1983; Browder et al., 1984; Charlop et al., 1985; Luciano, 1986; Smeets & Striefel, 1980; Snell, 1982; Touchette & Howard, 1984; Zane et al., 1984). The interval at which point the delay was not increased ranged from 2 to 10 secs.

Movement Through Delay Intervals

The process of increasing the delay interval was contingent upon subjects' responding correctly to a set number of trials (e.g., Braam & Poling, 1983; Luciano, 1986; Touchette & Howard, 1984) or was increased by sessions or blocks of trials (Browder et al., 1984; Snell, 1982). In addition, the delay interval was also changed (i.e., decreased) contingent upon subjects reponding incorrectly. Following one or a specified number of incorrect responses, trials were repeated (Braam & Poling, 1983), the delay was decreased on the next trial (Smeets & Striefel, 1980; Striefel et al., 1974; Touchette & Howard, 1984; Walls et al. 1982), or the 0 sec delay was used on the trial following the error and the delay progression was then reinstated (Browder et al., 1984; Smeets & Striefel, 1976; Snell, 1982).

An example of a study in which the delay progression changed contingent on student responding is the Zane et al. (1984) investigation. In this study, adults with severe retardation were taught international or community symbols. The delay interval was increased by 1 sec each time a correct resonse occurred up to a maximum delay of 4 secs. Following an incorrect response, the next trial was conducted at the 0-sec delay.

Some studies in the literature used PTD but did not provide procedural specifications (Aeschleman & Schladenhauffen, 1984; Barrera & Sulzer-Azaroff, 1983; McDonagh et al., 1984; McIlvane et al. 1984). For example, Barrera and Sulzer-Azaroff (1983) taught expressive labeling of objects to autistic children using a procedure in which following a simultaneous presentation of the object and the controlling prompt, the prompt was faded by "systematically increasing the delay between the request for a response (locative question) and the presentation of the vocal prompt" (p. 383). Other specific information on progression of delay intervals was not provided.

Consequences

Corrects Responses

Two types of correct responses can occur with PTD. A correct wait, (i.e. the subject responds correctly following the controlling prompt), or an anticipation, (i.e. the subject responds correctly before the presentation of the controlling prompt). Barrera and Sulzer-Azaroff (1983), Charlop et al. (1985), Luciano (1986), Smeets and Striefel (1976), Smeets and Striefel (1980), Snell (1982), Walls et al. (1982), and Zane et al. (1984) all provided the same consequence for a correct response regardless of whether it was an anticipation or wait. Some studies however, differentially reinforced anticipation and wait responses. Braam and Poling (1983) provided descriptive verbal praise and a token on a FR1 schedule for anticipations, but gave praise on a FR1 schedule and a token on a FR3 schedule for waits. In addition, Browder et al. (1984) gave the subject 2 tokens for an anticipation and only 1 token for a correct wait. Touchette and Howard (1984) taught 3 severely retarded children receptive identification of letters, words, and/or numbers. Three schedules of reinforcement of anticipations and waits were studied. In condition A, both waits (i.e., correct prompted) and anticipations (i.e., correct unprompted responses) received praise and a token on a CRF schedule of reinforcement. In condition B, anticipation responses were reinforced on a CRF schedule, while waits were reinforced on a FR3 schedule. Finally in condition C, anticipation responses received FR3 reinforcement, and waits were reinforced on a CRF schedule. Results indicated that for all subjects, fewer trials to criterion were required and the earliest transfer of stimulus control occurred when condition B was in effect (differential reinforcement of waits and anticipations).

Error Responses

The studies which specified the consequences for incorrect responses use verbal reprimands, timeout, modeling the correct response, or physically guiding the subject through the correct response. Charlop et al. (1985) used a verbal reprimand alone following incorrect responses, while Walls et al. (1982) used a model only for incorrects. Barrera and Sulzer-Azaroff (1983) and Luciano (1986) both used a 15-sec and 5-sec timeout, respectively. The timeout procedure consisted of removing the stimulus and looking away from the subject for a specified interval. Zane et al. (1984) and Touchette and Howard (1984) used a combination of a verbal reprimand (i.e. "No") and a 10 sec timeout during training. Four of the studies used a combination of verbal reprimand plus the experimenter providing a model or putting the subject through the correct response (Browder et al., 1984; Smeets & Striefel, 1976: Smeets & Striefel, 1980; Striefel et al., 1974). When an incorrect response occurred, Snell (1982) used a verbal reprimand, "No that's not how you make the bed," followed by physical guidance of the correct response and a 10-sec timeout.

Results

Effectiveness

All of the studies reviewed reported that the progressive time delay procedure was effective in teaching the targeted behavior. Three studies reported that an adaptation of the procedure or a change of behavior taught was necessary to raise responding to criterion levels. Charlop et al. (1985) changed the task of spontaneous manding for one subject. Instead of presenting only one stimulus and having the subject mand, "I want ___," both of the stimuli were presented at the same time and the subject manded for his choice. When this adaptation was implemented, the subject met criterion in 28 trials. Smeets and Striefel (1980) adapted the delay procedure for one of their subjects who was learning instruction-following. For this subject, on one instruction, the delay interval remained at 0-sec until 10 consecutive trials were correct. At this point, the time delay intervals were reinstated but a model was used simultaneously with the verbal instruction. The model was then discontinued and the original procedure was used. This modification was effective in raising the subject's responding to criterion levels. Snell (1982) adapted the behavior that was taught to one subject. Following no progress on the behavior of partially making a bed, the subject was successfully taught to strip the bed; a behavior which was learned quickly by the other subjects.

Efficiency

Efficiency data which have been reported in the literature include number of errors, percentage of errors, number of trials to criteria, percentage of unprompted responses, number of sessions to criterion, minutes of instructional time, the point of transfer of stimulus control, response accuracy, and rate of acquitiion (Barrera & Sulzer-Azaroff, 1983; Braam & Poling, 1983; Charlop et al., 1985; Goetz et al., 1983; Luciano, 1986; McDonagh et al., 1984; Smeets & Striefel, 1980; Snell, 1982; Streifel et al.,1974; Touchette & Howard 1984; Walls et al., 1982; Zane et. al., 1984).

Summary

Based on the literature reviewed, the following statements can be made:

- The PTD procedure has been used with autistic subjects and moderately, severely, and profoundly mentally retarded subjects.
- The majority of the PTD studies were conducted with secondary-age students or adults.
- The procedure has been used most frequently to teach discrete tasks.
- A model or a visual stimulus prompt were the most commmonly used controlling prompts.
- Skills have been taught successfully in isolation and in intermix instructional conditions.
- Delay intervals are most commonly increased in 1 sec increments.
- Most studies provided the same consequence for correct anticipation orwait responses, but differential reinforcement of correct waits and anticipations may be more effective and possibly more efficient.
- Most studies increased the delay interval based on student responding.
- Verbal reprimand and the experimenter providing a model or putting the subject through a correct response were the most commonly used correction procedures.
- All studies reviewed reported the procedure as effective.
- Most PTD studies reported some efficiency data.

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Naturalistic Teaching Strategies

Chapter 9

Mark Wolery, Patricia Munson Doyle, Melinda Jones Ault, and David L. Gast

The naturalistic teaching strategies involve embedding instructional trials within the context of ongoing routines and activities, and include such procedures as incidental teaching, the mand-model procedure, and naturalistic time delay (Halle, Alpert, & Anderson, 1984). Investigations where the independent variable was environmental arrangement and/or enrichment (e.g., Spangler & Marshall, 1983), differential reinforcement in the natural environment (e.g., Miller & Sloane, 1976), modeling (e.g., Seitz & Marcus, 1979), peer-mediated interventions (e.g., Odom, Hoyson, Jamieson, & Strain, 1985), behavioral rehearsal, role playing, and/or socio-dramatic play (e.g., McGee, Krantz, & McClannahan, 1984; Strain, 1975) were not included in this review. Although these procedures could be labled naturalistic strategies, the focus of this review is on teacher directed instructional strategies designed to transfer stimulus control from controlling stimuli to novel stimuli. Likewise, investigations where the naturalistic teaching strategies were used only to establish generalized responding of targeted responses (e.g., Hart & Risley, 1968; Carr & Kologinsky, 1983) were not reviewed.

Three naturalistic teaching procedures were analyzed: incidental teaching, mand-model procedure, and naturalistic time delay; for additional reviews see (Halle, 1982; Halle, et al., 1984; Hart & Rogers-Warren, 1978; Warren & Rogers-Warren, 1980; Warren, Rogers-Warren, Baer, & Guess, 1980). With each procedure the environment is modified to prompt the use of the target behavior, training occurs within the natural context and involves a brief interaction between the teacher and student, and the responses result in natural consequences. The trial sequences for these three procedures are shown in Figures 1, 2, and 3. With the incidental teaching strategy, a trial begins with a student's initiation of a request or interaction. The teacher determines whether to use that initiation as a teaching trial, and if so, focuses on the student and verifies the topic of the initiation. At this point, the teacher determines what response is desired from the student and what level of cue (attention only or attention plus a verbal cue) should be provided to obtain that response (Hart & Risley, 1975). If the student responds correctly, then access to the requested object, action, activity, etc. is provided. If the student does not respond correctly, assistance, usually in the form of a model, is provided. With the mand model strategy, a trial begins with the teacher initiating a mand (task direction) related to the student's focus of attention, and providing a short response interval. If students respond correctly, then they are reinforced; if they do not, then a model is provided. With the naturalistic time delay strategy, the environment is analyzed to identify routines that occur regularly (cf. Halle, Baer, & Spradlin, 1981). The routines are then assessed for steps where instruction can be provided, usually a step where teachers are currently providing assistance or not promoting independence. A trial begins when the student comes to the identified step, and the teacher delays the assistance for a specified number of seconds. If students respond correctly, they are reinforced and the routine continues. If students respond incorrectly or wait for assistance, a prompt, usually a model, is provided. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using these naturalistic teaching strategies are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

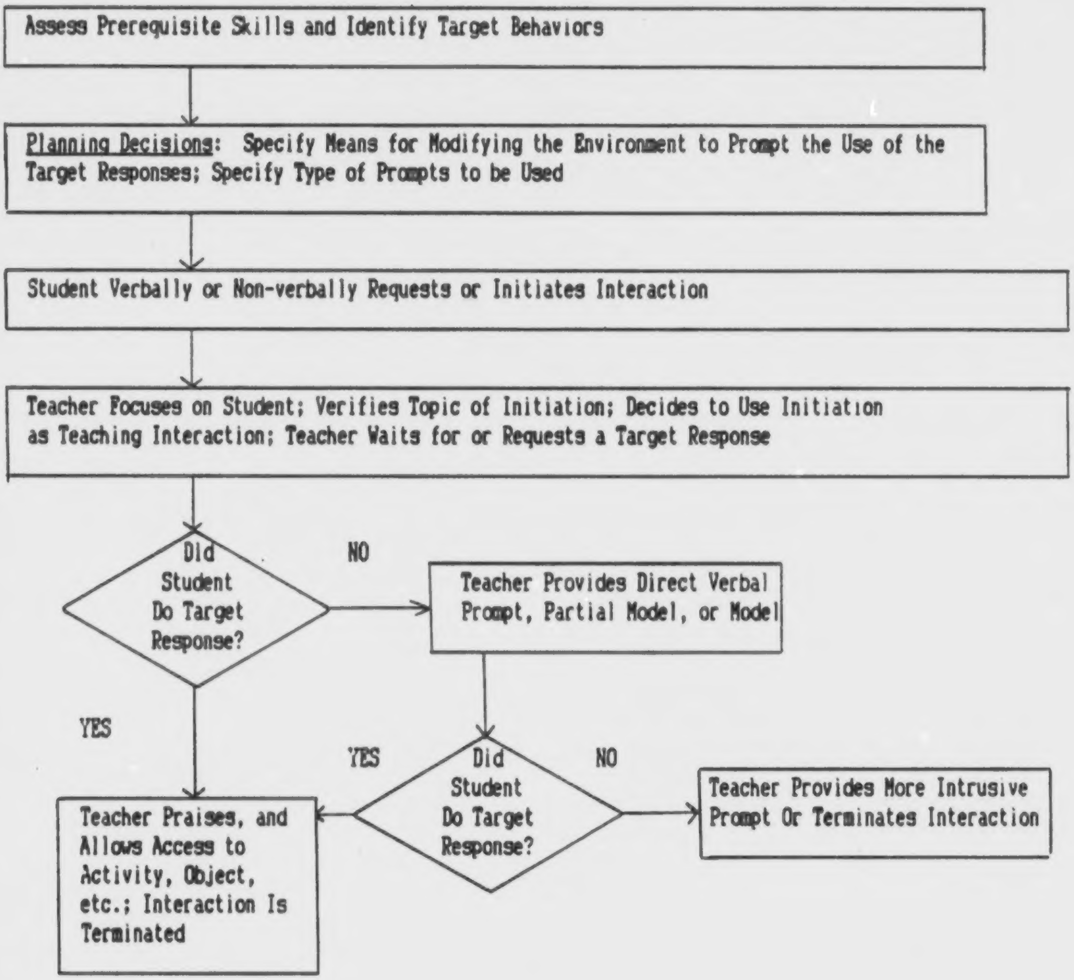
Assess Prerequisite Skills and Identify Target Behaviors
Planning Decisions: Specify Means for Modifying the Environment to Prompt the Use of the Target Responses; Specify Type of Prompts to be Used
Student Verbally or Non-verbally Requests or Initiates Interaction
Teacher Focuses on Student; Verifies Topic of Initiation; Decides to Use Initiation as Teaching Interaction; Teacher Waits for or Requests a Target Response
Did Student Do Target Response?
NO
Teacher Provides Direct Verbal Prompt, Partial Model, or Model
YES
YES
Did Student Do Target Response?
NO
Teacher Provides More Intrusive Prompt Or Terminates Interaction
Teacher Praises, and Allows Access to Activity, Object, etc.; Interaction Is Terminated

Figure 9.1 Flow chart depicting the incidental teaching strategy.

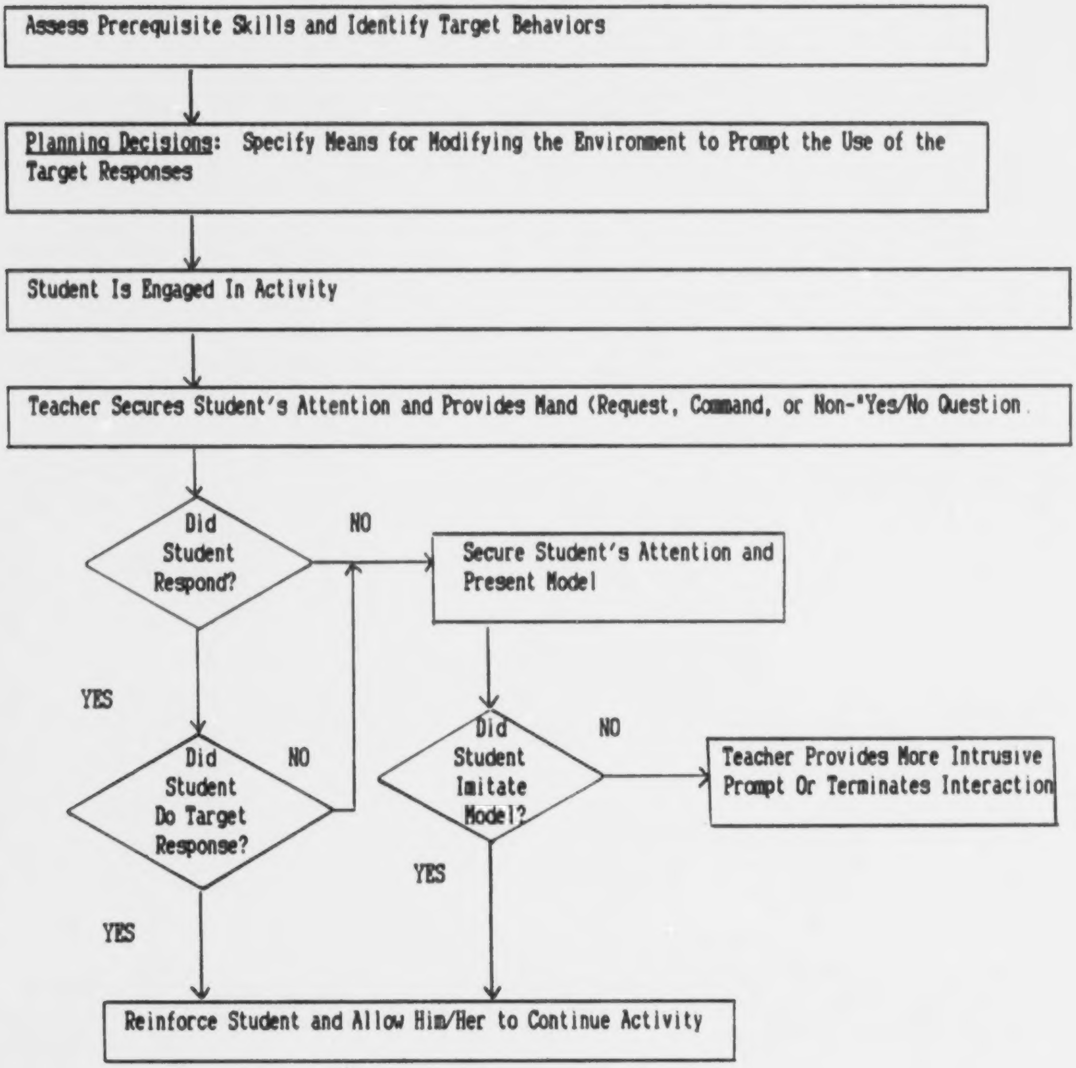
Assess Prerequisite Skills and Identify Target Behaviors
Planning Decisions: Specify Means for Modifying the Environment to Prompt the Use of the Target Responses
Student Is Engaged In Activity
Teacher Secures Student's Attention and Provides Mand (Request, Command, or Non-"Yes/No Question
Did Student Respond?
NO
YES
Secure Student's Attention and Present Model
Did Student Do Target Response?
NO
YES
Did Student Imitate Model?
NO
YES
Teacher Provides More Intrusive Prompt Or Terminates Interaction
Reinforce Student and Allow Him/Her to Continue Activity

Figure 9.2 Flow chart depicting the mand model teaching strategy.

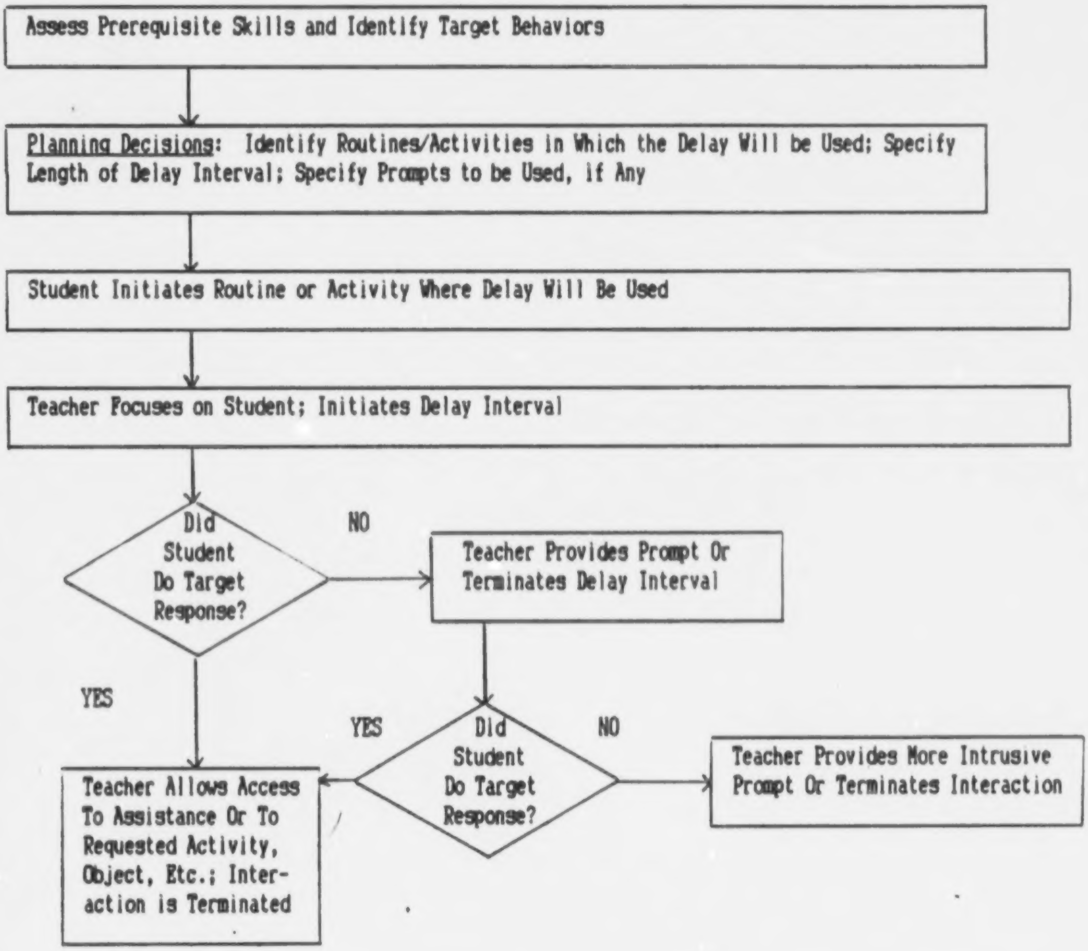
Assess Prerequisite Skills and Identify Target Behaviors
Planning Decisions: Identify Routines/Activities in Which the Delay Will be Used; Specify Length of Delay Interval; Specify Prompts to be Used, if Any
Student Initiates Routine or Activity Where Delay Will Be Used
Teacher Focuses on Student; Initiates Delay Interval
Did Student Do Target Response?
NO
Teacher Provides Prompt Or Terminates Delay Interval
YES
YES
Did Student Do Target Response?
NO
Teacher Provides More Intrusive Prompt Or Terminates Interaction
Teacher Allows Access To Assistance Or To Requested Activity, Object, Etc.; Interaction is Terminated

Figure 9.3 Flow chart depicting the naturalistic time delay strategy.

Table 1

Results of Investigations Using Naturalistic Teaching Strategies

Citation		Population Number/ Gender	Age/ Yrs	Diag- nosis	Setting	Behavior	Effective- ness	Efficiency	Generali- zation	Mainten- ance	Design
Cavallaro & Paulson (1985)		3M 1F	3.6-6.6	DD	CS	Any English word/sound (Express.)	+	S, Imitative Children > Non-imitative Children	N/D	+/-D	WTD/MB
Fabry et al. (1984)		5M 1F	12.75-22.17	MoMR SMR	IN	Sight word reading	4 Subj + 1 Subj A/+ 1 Subj -	T,S	P,S 4 Subj + P 1 Subj + P,S 1 Subj -	N/D	MB
Halle et al. (1979)		5M 1F	11.10-15.7	SMR PMR	IN	Express. request for meal tray	4 Subj + 2 Subj A/+	N/D	P 4 Subj+ 1 Subj- P,T 3 Subj+ 1 Subj-	4 Subj + 2 Subj +/-	MB
Halle et al. (1981)	Exper I	3M 3F	3-4.11	DD	CS	Vocal initiations	+	N/D	N/D	N/D	MB
	Exper II	5M 1F	5.11-9	DD	CS	Vocal initiations	+	N/D	N/D	N/D	MB
Hart & Risley (1974)		7M 5F	$\bar{X}$= 4.5	DD	CS	Express. nouns, noun-adjective, compound sentences	+	N/D	T+	N/D	MB
Hart & Risley (1975)		6M 5F	$\bar{X}$= 5	DD	CS	Express. compound sentences	+	N/D	P,T+	N/D	MB/ WTD
McGee et al. (1983)		1M 1F	12.7-15.10	Aut	CS	Recept object id.	+	N/D	S+	N/D	MB
Oliver & Halle (1982)	Exper 1	1M	7	MoMR	PS	Manual sign initiations	+	N/D	P+ T+/- S+/-	3W+/-	MB

Table 1 Continued

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs	Diagnosis							
Peck (1985)	6M 2F	10-14	Aut MoMR SMR PMR	PS	Social/ Communicative behavior	+	N/D	T 6 Subj+ T 2 Subj-	N/D	MB
Rogers-Warren & Warren (1980)	2M 1F	3.4-4.5	SLI	CS	Number of verbalizations	+	N/D	T+	7M+	MB
Schepis et al. (1982)	6M 3F	7-21	Aut PMR	IN	Manual signing	+	N/D	T+/-	17W+/-	MB
Warren et al. (1984)	1M 2F	2.11-3.7	SLI	CS	Verbalizations, verbal initiations, responsiveness, 2-word utterances	+	N/D	T,S+	+	MB

Table 2

Methods Used in Investigation with Naturalistic Teaching Strategies

Citation	Population Number/ Diagnosis		Behavior Name	Behavior Type	Strategy Used	Arrange Environment?	Teaching Interaction	Consequences Correct Responses	Consequences Error Responses
Cavallaro & Paulson (1985)	4	DD	Any English word/sound (Express.)	DS	Incid. Tching	Yes	S. requests, T. waits 3 sec for target response. If no response, T. provides QP, VI, PM, or MO	Access to requested object	Withheld requested object
Fabry et al. (1984)	6	MoMR SMR	Sight word reading	DS	MM	Yes	Token appears with sight word on it, T. says, "What word?" and/or points to word. If error, T. provides MO	Praise CRF	Provide MO and no Praise
Halle et al. (1979)	6	SMR PMR	Express. request for meal tray	DS	NTD	Yes	First Method: S. approaches meal counter, T. waits 15 sec for request.	Access to meal tray	Access to meal tray at end of 15 sec.
							Second Method: S. approaches meal counter, T. provides MO end of 15 sec delay	Access to meal tray	Access to meal tray 5 sec after MO
Halle et al. (1981) Exper I	6	DD	Vocal initiations	DS/ Ch	NTD	Yes	T. approaches S. holding object (e.g., juice), or T. orients toward S. who needed assistance. T. waits 5 sec, if no verbal initiation occurs, T. gives MO.	T. gives object or assistance	N/D
Exper II	6	DD	Vocal initiations				Same as Exper. I	Same as Exper. I	

CODES:

See Appendix A

Ch = Chained

DS = Discrete

Incid. Tching = Incidental Teaching

MM = Mand Model Procedure

NTD = Naturalistic Time Delay

Integ. Strat.= Integrated Strategies

S. = Student, T. = Teacher

QP = Question prompt

VP = Direct verbal prompt

PM = Partial model

MO = Model

FP = Full physical prompt

N/A = Not applicable

CRF = Continuous

S = Student

T=Teacher

MO= Model

FP= Full physical

N/A = Not applicable

N/D = Not defined

Table 2 Continued.

Citation	Population Number/ Diagnosis		Behavior		Strategy Used	Arrange Environment?	Teaching Interaction	Consequences	
			Name	Type				Correct Responses	Error Responses
Hart & Risley (1974)	12	DD	Express. nouns, noun-adjective, compound sentences	DS/ Ch	Incid. Tching	Yes	S. requests materials, T. waits 30 sec for target language response, and then implements prompt sequence: (1) QP, (2) VI, and (3) MO	access to requested materials	Next more intrusive prompt
Hart & Risley (1975)	11	DD	Express. compound sentences	Ch	Incid. Tching	Yes	Same as Hart & Risley (1974)	Access to materials	Next more intrusive prompt
McGee et al. (1983)	2	Aut	Recept object id.	DS	MM	No	T. asks S. if s/he was ready; if S. responds, "yes," then T. says, "Give me __." If S. not correct, T. points to correct object.	Descriptive praise	T. points to object
Oliver & Halle (1982) Exper 1	1	MoMR	Manual sign initiations	DS	Integ. Strat.	Yes	T. waits 10 sec in routine; if no correct sign, T. gives FP, MO, or VI.	Request fulfilled	T. gives prompt & request fulfilled
Peck (1985)	8	Aut MoMR SMR PMR	Social/ Communicative behavior	DS	Integ. Strat.	Yes	T. arranges environment for social/communicative behavior; if none, T. mands.	T. imitates, elaborates S. response; T. complies with request	N/A
Rogers-Warren & Warren (1980)	3	SLI	Number of verbalizations	DS/ Ch	MM	Yes	T. notes S. attention to materials and mands; if no response, T. gives VI and/ or MO	Access to materials and praise	Elaborate mand &/or model provided
Schepis et al. (1982)	9	Aut PMR	Manual signing	DS	Integ. Strat.	Yes	Method 1: S. near materials; T. waits 5 sec; if no response T. gives QP and/or mand Method 2: T. mands for sign; if no response, T. gives FP. Method 3: T. mands for sign; if no response, T. gives FP; T. varys mand; if no response, T. gives FPP.	Access to materials, praise	T. gives FP & praise for compliance
Warren et al. (1984)	3	SLI	Verbalizations, verbal initiations, responsiveness	DS/ Ch	MM	No	T. approaches S., mands, and waits; if no response, T. provides MO.	Praise, continued attention	T. stops interaction

Behavior/Population

The naturalistic teaching strategies were used primarily to teach expressive language skills, such as vocal initiations (e.g., Halle et al. 1981), noun-adjective combinations (Hart & Risley, 1974), compound sentences (Hart & Risley, 1975), manual signs (Oliver & Halle, 1982), and general expressive language skills (Cavallaro & Paulson, 1985; Warren, McQuarter, & Rogers-Warren, 1984). Receptive language skills were targeted in one study (McGee, Krantz, Mason, & McClannahan, 1983), and sight word reading was targeted in another (Fabry, Mayhew, & Hanson, 1984). In one investigation, various categories of social/communicative behaviors were taught (Peck, 1985). Chained responses were taught in five studies (Halle et al., 1981; Hart & Risley, 1974, 1975; Rogers-Warren & Warren, 1980; Warren et al., 1984), but discrete responses were targeted in all studies except the Hart and Risley (1975) investigation. In nearly all cases, the discrete responses were single word utterances or expressive signs; the chained responses consisted of phrases (e.g., Halle et al., 1979), sentences (Warren et al., 1984), or compound sentences (Hart & Risley, 1974, 1975).

The students involved in these investigations were preschoolers (Cavallaro & Paulson, 1985; Hart & Risley, 1974; 1975; 1980; Warren et al., 1984), elementary-aged (Oliver & Halle, 1982; Schepis et al, 1982), adolescents (Fabry et al., 1984; McGee et al., 1983; Peck, 1985), and young adults (Fabry et al., 1984; Schepis et al., 1982). The most attention has been given to preschoolers and adolescents or young adults in the naturalistic teaching literature; less attention has been given to elementary-aged students. Participating students included children with developmental delays from economically disadvantaged environments (Hart & Risley, 1975; 1974; 1980) and children of normal intelligence (Hart & Risley, 1980). Students with language delays (Warren, et al., 1984), moderate mental retardation (Fabry et al., 1984), severe mental retardation (Halle, Marshall, & Spradlin, 1979), profound mental retardation (Halle et al., 1979), autism (Peck, 1985; Schepis et al., 1984), and a variety of developmental delays (Cavallaro & Paulson, 1985) participated in the investigations.

Type of Naturalistic Teaching Stragtegy

Twelve investigations were found that used the naturalistic teaching strategies. Three studies used incidental teaching (Cavallaro & Paulson, 1985; Hart & Risley, 1974, 1975), four used the mand model strategy (Fabry et al., 1984; McGee et al., 1983; Rogers-Warren & Warren, 1980; Warren et al., 1984), two used the naturalistic time delay strategy (Halle et al., 1979, Halle et al., 1981), and three used integrated strategies (combinations of two or more of these procedures) (Peck, 1985; Oliver & Halle, 1982; Schepis et al., 1982). Two of the investigations (Fabry et al., 1984; McGee et al., 1983) that used the mand model strategy called it a modified incidental teaching procedure. These studies are labeled as mand model investigations because their procedures match the operational definition of the mand model strategy more closely than the incidental teaching strategy.

Procedural Variations of the Naturalistic Teaching Procedures

Incidental teaching. The three incidental teaching studies all involve some manipulation of the environment to promote use of the targeted responses. Cavallaro and Paulson (1985) had teachers give smaller amounts of food at snacks to increase the likelihood that children would request more food. Certain materials were placed on a shelf that was within students' sight, but was out of their reach in both of the Hart and Risley (1974, 1975) investigations. In these studies, the initial response interval after the student initiation was 3 sec (Cavallaro & Paulson, 1985) and 30 sec (Hart & Risley, 1974). If no response or an unsatisfactory response occurred within this interval, the teacher provided a series of increasingly intrusive prompts (Hart & Risley, 1974, 1975) or selected a prompt that had a high probability of being controlling (Cavallaro & Paulson, 1985). In all three studies, a full model of the target response was the most intrusive level. All incidental teaching studies involved preschool or early elementary-aged students and targeted language responses.

Mand model procedure. Two of the four mand model investigations made some manipulation of the environment. For example, Fabry et al. (1984) wrote the targeted sight words on some of the tokens students received for correct responses and appropriate social behavior throughout the school day; the mand model procedure was used during token exchange. Rogers-Warren and Warren (1980) provided materials and activities that would be of interest to the students. McGee et al. (1983) and Warren et al. (1984) apparently did not manipulate the environment. In the mand model procedures, the teacher initiated the instructional trial (interaction). Fabry et al. (1984) initiated a trial whenever the student attempted to exchange a token that had a target word written on it; McGee et al. (1983) initiated a trial by asking students whether they were ready to make a lunch, an affirmative response was required from the student prior to the presentation of the mand; Rogers-Warren and Warren (1980) and Warren et al. (1984) initiated trials when students focused their attention or were engaged in ongoing classroom activities. The controlling prompt in the mand model studies was a model (Fabry et al., 1984; Rogers-Warren & Warren, 1980; Warren et al., 1984) and a point to the correct object from a display of four objects (McGee et al., 1983); however, direct verbal prompting was also used in the Rogers-Warren and Warren (1980) investigation.

Naturalistic time delay. Both naturalistic time delay studies (Halle et al., 1979, 1981) employed some arrangement of the environment; specifically, adult assistance that usually was provided for specific parts of routines was delayed. The delay intervals used included 15 sec (Halle et al., 1979) and 5 sec (Halle et al., 1981). This interval must be of sufficient duration to allow the delay to be discriminable by the students (Oliver & Halle, 1982). In the Halle et al. (1979) study, a model was provided at the end of the 15-sec delay only after the delay interval alone was not functional; in the Halle et al. (1981) study, a model was provided at the end of the response interval if students did not initiate an appropriate language response. The model was a controlling prompt for all students in both studies; however, one student in the Halle et al. (1979) study required use of the progressive time delay procedure.

Integrated naturalistic procedures. The integrated studies involved combinations of procedures, although analysis of the various components was not systematically investigated. The three integrated studies involved some arrangement of the environment. Oliver and Halle (1982) and Peck (1985) inserted delays in ongoing routines and activities, and Schepis et al. (1982) restricted access to materials to instances where students' apparently requested their use. In the Oliver and Halle (1982) study, a naturalistic time delay was inserted into specific routines, and if no response occurred at the end of the 10-sec delay, then the teacher provided either a model, direct verbal prompt ("you need to show me the sign for ___."), or a full physical prompt (i.e., molding the students' hand to form the manual sign). The prompts were provided contingent upon absence of the correct manual sign at the end of the delay interval. Thus, the procedure was different from the incidental teaching studies in that the student was not required to initiate the training trial. In the Peck (1985) investigation, teachers arranged the environment to increase the probability of social/communicative behavior, and then imitated or elaborated the students' responses when they occurred. However, if a response was not forthcoming, a choice and indirect verbal cues were provided to increase the likelihood of communicative behaviors. Specific extra stimulus prompts were not systematically programmed and implemented. In the Schepis et al. (1982) investigation, three methods were used. If the student was near the restricted materials shelf, the teacher waited 5 sec and then provided a question prompt and/or a mand. The second method involved the teacher providing mands and then a full physical prompt if a manual sign did not follow the mand. The third method involved short instructional sessions where teachers provided a variety of mands and full physical prompts that required the students to use the targeted signs.

Consequences

Corrects Responses

Correct responses in the incidental teaching studies resulted in access to requested materials, objects, or assistance (Cavallaro & Paulson, 1985; Hart & Risley, 1974, 1975). In the mand model studies, correct responses resulted in praise (Fabry et al., 1984; McGee et al., 1983); continued access to materials and praise (Rogers-Warren & Warren, 1980); and praise, continued access to materials, and continued access to teacher attention (Warren et al., 1984). In the naturalistic time delay studies, correct responses resulted in access to the requested objects and or assistance (Halle et al., 1979, 1981). In the integrated studies, correct responses resulted in teacher compliance with the requests (Oliver & Halle, 1982), compliance with requests plus imitation and/or elaboration of the students' behavior (Peck, 1985), and access to materials and praise (Schepis et al., 1982).

Error Responses

Error responses in the incidental teaching studies resulted in the presentation of more intrusive prompts (Cavallaro & Paulson, 1984; Hart & Risley, 1974, 1975) and if errors persisted, access to the requested object was withheld (Cavallaro & Paulson, 1985). Errors in the mand model procedure resulted in cessation of the interaction (Warren et al., 1984), presentation of a more elaborate mand and/or model (Rogers-Warren & Warren, 1980), presentation of a controlling gestural prompt (point) (McGee et al., 1983), and presentation of a model but no praise (Fabry et al., 1984). Errors with the naturalistic time delay strategy resulted in access to the materials at the end of the time delay interval (Halle et al., 1979), and access to the materials 5 sec after the model (Halle et al., 1981). In the integrated studies, errors resulted in a prompt and teacher compliance with the request (Oliver & Halle, 1982), no systematic teacher response (Peck, 1985), and a full physical prompt and praise for compliance with the prompt (Schepis et al., 1982).

Results

Effectiveness

All of the studies reviewed reported that the naturalistic teaching strategies were effective in teaching the targeted behaviors. One study reported that one of six students did not learn with the mand model procedure

(Fabry et al., 1984). Further, they stated the mand model procedure was only partially effective with another student. Halle et al. (1979) found that the naturalistic time delay procedure was effective with three students, but certain modifications of the procedure were required for three students. For two of those three, the addition of a model after the delay interval (i.e., similar to the constant time delay procedure, see Chapter 7) was sufficient to produce learning. For the third student, a progressive delay procedure was used and was effective. Interestingly, the three students for whom the naturalistic time delay strategy was effective had observed other students being trained with the procedure. Although some investigations taught target skills to criterion (e.g., Fabry, et al., 1984), most studies (e.g., Hart & Risley, 1975; Peck, 1985; Warren et al., 1984) provided data indicating that performance under naturalistic teaching conditions was greater than that under baseline conditions.

Little maintenance data were reported, and when such data were collected, mixed results or partial maintenance occurred with incidental teaching (Cavallaro & Paulson, 1985), naturalistic time delay (Halle et al., 1979), and integrated strategies (Oliver & Halle, 1982; Schepis et al., 1982). When measured, the mand model procedure resulted in stable maintenance (Rogers-Warren & Warren, 1980; Warren, 1984).

More attention has been given to generalization of behaviors taught with naturalistic teaching procedures. Hart and Risley (1974, 1975) reported that new langauge behaviors (e.g., new nouns, new compound sentences) appeared that had not received training with incidental teaching. Further, as students learned to perform certain language behaviors with teachers, they also directed those responses to other children. Hart and Risley (1980) compared students who had received a year of incidental teaching to two groups of children who had not experienced systematic use of the strategy. One of the comparison groups consisted of children from economically disadvantaged environments (similar to subjects who received incidental teaching) and the second group consisted of children who were not economically disadvantaged. The initial rates of talking and patterns of language use of the two economically disadvantaged groups was similar. Over the course of the school year, the amount of talking in the two comparison groups remained relatively constant, but increased for children who experienced incidental teaching. Further, the patterns of language use in terms of vocabulary and elaborate language forms for the economically disadvantaged children became similar to the patterns displayed by students who were not economically disadvantaged.

Halle et al. (1979) used naturalistic time delay and assessed generalization across persons and across persons and meal times. Four of the five students generalized across persons, and three of four generalized across persons and settings.

Generalization of language skills taught with the mand model procedure were assessed also. Fabry et al. (1982) found that four of six subjects generalized sight word reading from the classroom to another room with another adult. A fifth subject did not generalize, but after the sessions were conducted in the classroom, the student began to perform in the generalization setting. The sixth student did not acquire the responses, thus, generalization performance could not be assessed. McGee et al. (1983) taught students in the kitchen to receptively identify foods for making lunches; generalization of the receptive skills was assessed by the trainer in daily sessions in the dining room (i.e., another setting). Generalization occurred for both students. Rogers-Warren and Warren (1980) found that the mand model procedure could effectively establish generalization of language trained in isolated settings to the classroom. Warren et al. (1984) also documented generalization of trained language behaviors across free play settings.

Schepis et al. (1982) used integrated naturalistic procedures to teach students to use manual signs and assessed generalization to vocalizations. Their results were consistent with earlier research on this issue; that is, generalization from signing to vocalizations occurred with some students but not with all. Oliver and Halle (1982) probed for generalization across four routines different from those used in training. Generalization consistently occurred in two of the four routines. No explanation was found for the failure to secure generalized responding in the remaining two routines. Generalization did occur across trainers. Peck (1985) also found mixed generalization results.

Efficiency

Almost no efficiency data were reported in the investigations using the naturalistic teaching procedures. Cavallaro and Paulson (1985) reported that children who were imitative learned more rapidly with the incidental teaching procedure than children who were not imitative. Fabry et al. (1984) reported the number of teaching interactions (trials) and sessions to criterion. For their six subjects these variables were correlated with IQ and Social Quotients; the higher students' intelligence and social quotients, the fewer the number of trials required.

Teacher Behavior

Seven of the studies trained and/or assessed teachers' implementation and/or their ratings of the social validity of the incidental teaching procedure (Cavallaro & Paulson, 1985), naturalistic time delay (Halle, et al., 1979, 1981), mand model procedure (Rogers-Warren & Warren, 1980; Warren et al., 1984), and integrated naturalistic strategies (Peck, 1985; Schepis et al., 1982). Training usually consisted of brief oral descriptions of the procedures, models, role playing, and periodic feedback. The results of those measures suggest that (a) teachers can implement the procedures with short sessions of training, (b) teachers can implement the procedures with accuracy, and (c) teachers rate the naturalistic procedures positively. For a systematic approach to train perschool teachers to use incidental teaching, see Mudd and Wolery (in press).

Summary

Based on the literature reviewed, the following statements can be made:

- The naturalistic teaching strategies were used effectively to teach expressive language behaviors to preschoolers and adolescentss; they were used less frequently to teach receptive language skills and elementary students.
- Students handicapping conditions included communication deficits, autism, and moderate, severe, and profound mental retardation.
- Discrete and chained responses were taught with the naturalistic procedures, but discrete responses were more frequently taught.
- Several variations of naturalistic teaching strategies exist including incidental teaching, naturalistic time delay, the mand model procedure, and integrated (combined) procedures.
- Environmental modifications (e.g., restricted material shelves, delay intervals inserted into naturally occurring routines) designed to prompt the occurrence of the targeted responses were used in all investigation except for two which employed the mand model procedure.
- Correct responses resutled in natural reinforcers such as access to requested objects and assistance, or completion of routines.
- Efficiency data is collected infrequently in studies using naturalistic teaching procedures.

- Generalization data were collected more frequently than maintenance data, and when collected both types of data suggested mixed results.

- Over half of the investigations include measures of teachers implementation and/or value judgments relative to the procedures. Teachers were able to implement the procedures given relatively short training sessions, models, and periodic feedback.

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Stimulus Manipulation

Chapter 10

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Stimulus manipulation procedures involve the gradual change of instructional stimuli in a systematic sequence. A stimulus is initially presented in a form where the subject can respond correctly. This stimulus is then gradually changed until the subject responds correctly to the target stimulus. "The goal of stimulus manipulation procedures is to gradually shift stimulus control from stimuli to which children can initially respond correctly to naturally occurring stimuli without errors or with a minimum of errors" (Wolery & Gast, 1984, p. 66). Two kinds of stimulus manipulation procedures were reported in the literature: stimulus shaping and stimulus fading. With stimulus shaping, the relevant dimension of the stimulus is changed until the subject can respond correctly to the target stimulus. With stimulus fading, some other aspect (irrelevant dimension) of the stimulus (e.g. color, intensity, size) is added to the stimulus and gradually changed until the subject can make the correct discrimination (Etzel & LeBlanc, 1979; Wolery & Gast, 1984). Stimuli are changed in a systematic sequence of steps and subjects move through the sequence by reaching a criterion at each step.

The trial sequence for stimulus manipulation strategies is shown in Figure 1, and involves the presentation of the stimulus at a specific step in a sequence. The participant is given the opportunity to respond and consequences are provided for correct or incorrect responses. A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using stimulus manipulation procedures are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

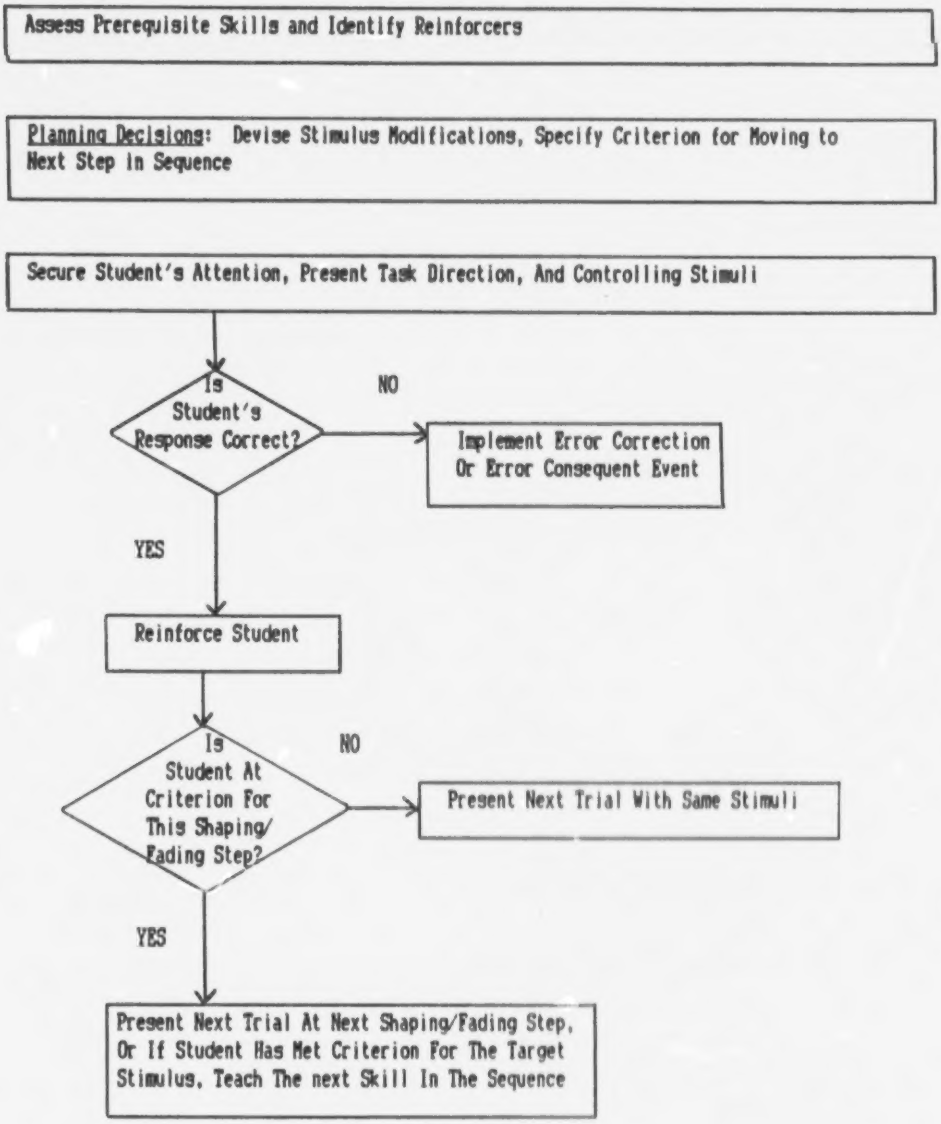
Assess Prerequisite Skills and Identify Reinforcers
Planning Decisions: Devise Stimulus Modifications, Specify Criterion for Moving to Next Step in Sequence
Secure Student's Attention, Present Task Direction, And Controlling Stimuli
Is Student's Response Correct?
NO
Implement Error Correction Or Error Consequent Event
YES
Reinforce Student
Is Student At Criterion For This Shaping/Fading Step?
NO
Present Next Trial With Same Stimuli
YES
Present Next Trial At Next Shaping/Fading Step, Or If Student Has Met Criterion For The Target Stimulus, Teach The next Skill In The Sequence

Figure 10.1 Flow chart depicting the stimulus manipulation strategy.

Table 1

Results from Investigations Using the Stimulus Manipulation Strategies

Citation	Population Number/ Gender	Age/ Yrs	Diag- nosis	Setting	Behavior	Effective- ness	Efficiency	Generali- zation	Mainten- ance	Design
Deckner & Blanton (1980)										
Beh. I	15M 5F	5.25 16.92	DD SBD	SS	Visual discrimination (numerosity)	+/-	N/D	N/D	N/D	GR
Beh. II	15M 5F	5.25 16.92	DD SBD	SS	Visual discrimination (brightness)	+/-	S T	N/D	N/D	GR
Goetz et al. (1983)	2M	4; 5	MH	PS	Responding to auditory cues	+	S	N/D	+/-N/D	
Irvin (1976)	24N/D	16- 43	SMR	IN	Visual discrimination	+/-	E T	N/D	N/D	GR
Lancioni (1983)										
Beh. I	2M 1F	8.5- 12.8	SMR Aut	IN	Match to picture	+	S E	T+	N/D	MP
Beh.II	2M 1F	8.5 12.8	SMR Aut	IN	Match body position to picture	+	S E	T+	N/D	MP
Lancioni et al. (1984)										
Beh. I	2F 1M	14.1- 16.8	DD VI HI	IN	Match objects to miniatures	+	T E S	T+	N/D	MP
Beh. II	2F 1M	14.1- 16.8	DD VI HI	IN	Match body position to doll's position	+	T E S	T+	N/D	MP

Table 1 Continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs	Diagnosis							
LaVigna (1977)	2M 1F	17-18	AUT	IN	Recept/Express id. of words	+	T E	N/D	N/D	N/D
Mackay (1985)	3M	Teenage	SMR	SS	Word construction	+/-	E	T+	N/D	TT
McIlvane et al. (1984)										
Beh. I	2M	25; 27	S/PMR	SS	Match spoken word to food	+	T E	N/D	N/D	N/D
Beh. II	2M	7	S/PMR Aut	SS	Match spoken word to food	+	T E	N/D	N/D	N/D
Smeets et al. (1985) Exper I	6M 2F	11.7-16.7	MoMR	SS	Receptive id. of written words written words	V1=V2	T V1=V2 E V1=V2	N/D	N/D	MP AT
Variable 1 - stimulus shaping; Variable 2 - stimulus shaping and letter discrimination										
Smeets et (1984) Exper I	2M 3F	12.9-13.3	MiMR	SS	Discrimination of missing minuend problems	4 Subj + 1 Subj +/m	T M E	T+	+W	MP
Exper II	4M	8.4-15.4	MiMR	SS	Discrimination of missing minuend problems	V1+ V2+/A	M E	T+	+W	MP
Variable 1 - stimulus shaping; Variable 2- revised program										
Stoddard & Gerovac (1981)	16M 1F	11-26	MoMR SMR PMR	IN	Place token in slot	+	T E	T+/-	+/-M	N/D

Table 2

Methods from Investigations Using the Stimulus Manipulation Strategies

Citation	Population		Behavior		Procedure		How Stimuli Were Manipulated	Criterion for Manipulation of Stimuli	Consequences Correct Responses	Error Responses
	Number/Diagnosis		Name		Shaping	Fading				
Deckner & Blanton (1980)										
Beh. I	20	DD SBD	Visual discrim. (numerosity)	DS	X		10 dots vs. empty screen, added 1 dot at a time	80% correct, move to next step	edibles, doorbell chimes	N/D
Beh. II	20	DD SBD	Visual discrim. (brightness)	DS	X		10 dots vs. dark screen, added 8 levels of brightness	80% correct, move to next step	edibles, doorbell chimes	N/D
Goetz et al. (1983)	2	MH	Responding to auditory cues	DS		X	Pair light and auditory: fade light intensity	90% for 2/3 days, move to lower intensity	edible	FP
Irvin (1976)	24	SMR	Visual discrimination of nut	DS	X		Raised vs. flat face of nut, decreased height of raised side	20 correct, move to next step	social, verbal praise	VR VI FP or PP as needed
CODES	See Appendix A		See Appendix A	Ch = chained DS = discrete			S+ = correct stimulus S- = incorrect stimulus		CRF = continuous reinforcement VR = variable ratio	VR = verbal reprimand VI = verbal instruct. PP = partial physical FP = full physical N/D = not defined

Table 2 continued.

Citation	Population Number/Diagnosis		Behavior Name	Type	Procedu Shaping	Fading	How Stimuli Were Manipulated	Criterion for Manipulation of Stimuli	Consequences Correct Responses	Error Responses
Lancioni (1983)										
Beh. I	3	SMR Aut	Match object to picture	DS	X		Picture of object, gradually changed shape of picture	3 corrects, move to next step	praise CRF, tangible faded on VR over trials	FP
Beh. II	3	SMR Aut	Match body position to picture	DS	X		Same as above	N/D	Same as above	N/D
Lancioni et al. (1984)										
Beh. I	3	DD VI HI	Match objects to miniatures	DS		X	Two full-size objects, size of one object gradually reduced	4-5 correct, move to next step	social praise CRF, tangible faded over trials	N/D
Beh. II	3	DD VI HI	Match body position to doll's position	DS	X		Shape of doll gradually changed	6 correct, move to next step	social praise CRF, tangible faded over trials	N/D
LaVigna (1977)	3	Aut	Recept./ Expres. id. of words	DS		X	S+ word presented, S- words gradually added and letters blackened	If 90% correct 1st time introduced, move to next level. Otherwise 90% correct for 3 sessions, move to next step	social praise, edibles	10 sec. in-seat timeout
Mackay (1985)	3	SMR	Word Construction	DS	X		All letters of word initially presented, gradually removed one letter at a time.	1 correct, move to next step	token, praise	no token

Citation	Population Number/Diagnosis		Behavior Name	Type	Procedu Shap-ing	Fad-ing	How Stimuli Were Manipulated	Criterion for Manipulation of Stimuli	Consequences Correct Responses	Error Responses
McIlvane et al. (1984)										
Beh. I	2	SMR PMR	Match spoken word to food	DS	X		Food in 2 compartments: screen covered progressively more of compartment	Minimum 1 trial at each step	edible	trial ended
Beh. II	2	Aut	Match spoken word to food	DS	X		Food in 2 boxes: box gradually covered with screen	1 subject-10 trials each step, 1 subject-5 trials each step	edible	trial ended
Smeets et al. (1985)										
Exper. I	8	MoMR	Receptive id. of written words	DS	X		Exaggerated lines of letters, gradually decreased width of lines.	10 correct, move to next step	praise, token	VR, repeat instruction
Variable 1 - Stim. shap.: Variable 2 - Stim. shap. and letter discrim.										
Smeets et al. (1984)										
Exper. I	5	MiMR	Discrim. of missing minuend problems	DS	X		Visual prompt presented. lines of prompt gradually faded	3 ditto sheets of correct target problems and 14/15 correct non-target problems. move to next step	praise, mark record form, sticker when met criterion on step	call attention to relevant dimensions
Exper. II	4	MiMR	Discrim. of missing minuend problems	DS	X		Visual prompt presented. lines of prompt gradually faded	90% correct target and non-target problems and no operation error for 2, 3 or 5 sheets	Same as above	Same as above
Variable 1 - Stim. shaping; Variable 2 Revised program										

Table 2 continued.

Citation	Population		Behavior		Procedu		How Stimuli Were Manipulated	Criterion for Manipulation of Stimuli	Consequences	
	Number/Diagnosis		Name	Type	Shaping	Fading			Correct Responses	Error Responses
Stoddard & Gerovac (1981)	17	MoMR SMR PMR	Place token in slot	DS	X		String attached to token, gradually increased distance of token from slot.	Minimum 1 correct, move to next step	edible, ringing bell, flashing light	trial ended

Behavior/Population

Stimulus manipulation procedures were used to teach visual discrimination tasks (Deckner & Blanton, 1980; Irvin, 1976; Smeets, Lancioni, Striefel, & Willemson, 1984), responses to auditory cues (Goetz, Gee, & Sailor, 1983), match-to-sample skills (Lancioni, 1983; Lancioni, Smeets, & Oliva, 1984; McIlvane, Withstandley, & Stoddard, 1984), fine motor skills (Stoddard & Gerovac, 1981), and cognitive skills such as receptive/expressive identification of words (LaVigna, 1977; Smeets, Hoogeveen, Striefel, & Lancioni, 1985), and word construction (Mackay, 1985). All of the behaviors taught in these studies were discrete tasks. The population involved in these studies included subjects with mild, moderate, severe, and profound mental retardation, autism, behavior disorders, and multiple handicaps. Ages ranged from preschoolers to adults across studies.

Names of Procedures

The majority of the studies changed stimuli based on the relevant dimension (stimulus shaping) and have been referred to in the literature as brightness-fading (Deckner & Blanton, 1980), easy-to-hard procedure (Irvin, 1976), anagram training (Mackay, 1985), prompt fading (Smeets et al., 1985), and stimulus shaping (Lancioni, 1983; Lancioni et al., 1984; McIlvane et al., 1984; Stoddard & Gerovac, 1981; Smeets et al., 1984). Only three reviewed studies manipulated an irrelevant dimension of the stimulus and can be identified as stimulus fading procedures. These procedures were referred to as fading (Goetz et al., 1983), stimulus fading (Lancioni et al., 1984), and errorless training (LaVigna, 1977).

Manipulation of Stimuli

In all of the studies reviewed, the instructional materials were manipulated (e.g. Deckner & Blanton, 1980; LaVigna, 1977; Smeets et al., 1985), or, in one instance, an added prompt was manipulated (Goetz et al., 1983). Stimuli were changed from discriminations the subject could initially make to the criterion target discrimination. Relevant dimensions which have been manipulated in the reviewed stimulus shaping investigations included the dimension of intensity (Deckner & Blanton, 1980), size (Irvin, 1976), shape (Lancioni, 1983; Lancioni et al., 1984; McIlvane et al., 1984; Smeets et al., 1985; Smeets et al., 1984), shape and position (Mackay, 1985), distance (Stoddard & Gerovac, 1981), and number (Deckner & Blanton, 1980). For example, Irvin (1976) taught 24 adults with severe retardation to discriminate between the raised and flat sides of an axle nut. The size of the raised side of the nut was initially increased to a height where the subjects could correctly discriminate between flat and raised. The height of the raised side was then systematically decreased until the subjects responded correctly to the target stimuli.

In the stimulus fading studies, the stimuli were manipulated on the irrelevant dimensions of intensity of the brightness of light (Goetz et al., 1983), size (Lancioni et al., 1984), and color (LaVigna, 1977). An example of fading on the dimension of size when the relevant dimension was shape, was presented in Lancioni et al. (1984). The experimenters taught 3 adolescents with multiple handicaps to match a full-size object to a miniature of the same object in a 3-choice format. Initially, a full-size object was presented and the subjects matched it with an identical full-size object. Across trials, the sample object was gradually decreased until the subject could match the miniature to the full-size object.

Movement through Shaping/Fading Sequence

In all of the stimulus manipulation studies, a specific criterion was defined for moving from one shaping/fading step to another. In order for subjects to move to the next step in the sequence they were required to attain a specific percentage of correct responses (Deckner & Blanton, 1980; Goetz, et al., 1983; LaVigna, 1977) or a specified number of correct responses (e.g. Irvin, 1976; Lancioni, 1983; Stoddard & Gerovac, 1981).

In addition to progressing to the next step in a sequence following correct responses, five studies specified procedures for returning to a previous step following incorrect responses. Deckner and Blanton (1980), Mackay (1985), Stoddard and Gerovac (1981) and Smeets et al. (1985) all stated that subjects returned to the previous step in the sequence following a number of incorrect responses. In the McIlvane et al. (1984) study, subjects returned to a previous step following incorrect responses and at the beginning of each instructional session.

An example of movement through a sequence of steps is described by Smeets et al. (1985). Eight adolescents with moderate retardation were taught to receptively identify words. A stimulus shaping procedure was compared with a stimulus shaping procedure plus a letter discrimination procedure. In both procedures, the width of the distinctive feature of the first letter in the S+ word was thickened. Following 10 correct responses, subjects moved to the next step in the sequence which gradually decreased the width of the line. If 10 correct responses were not attained, the subject returned to the previous step. The stimulus shaping plus letter discrimination procedure consisted of the procedure described above plus the subjects placed plastic letters over the letters of the S+ word after a correct response. Both procedures were found to be equally effective.

Consequences

Correct Responses

Consequences for correct responses occurred regardless of the step in the sequence being used. Consequences included praise (Irvin, 1976), praise plus tokens (Mackay, 1985; Smeets et al., 1985; Smeets et al., 1984), praise plus tangibles (Lancioni, 1983; Lancioni et al., 1984), edibles (Goetz et al., 1983; McIlvane et al., 1984), edibles plus praise (LaVigna, 1977), and edibles plus chimes or bells (Deckner & Blanton, 1980; Stoddard & Gerovac, 1981).

Incorrect Responses

Nine studies specified consequences for incorrect responses. Some of the procedures required the subject to perform the correct response or provided more information to the subject following an error. Goetz et al. (1983), Irvin (1976), and Lancioni (1983) provided physical prompts following an incorrect response. Smeets et al. (1985) provided a verbal reprimand and repeated the S^D while Smeets et al. (1984) interrupted the incorrect response and called the subject's attention to the relevant dimension. The remaining studies did not provide the correct response but instead provided a 10-sec. in-seat timeout (LaVigna, 1977), witheld a token (Mackay, 1975), witheld an edible (Stoddard & Gerovac, 1981), or ended the trial (McIlvane et al., 1984).

Results

Effectiveness

The majority of the stimulus manipulation procedures reported that stimulus shaping (Lancioni, 1983; Lancioni et al., 1984; McIlvane et al., 1984; Stoddard & Gerovac, 1981; Smeets et al., 1985), and stimulus fading (Goetz et al., 1983; Lancioni et al., 1984, LaVigna, 1977) were effective procedures in teaching the target behaviors. The remainder of the stimulus shaping procedures were not totally effective in that some subjects met criterion where others did not (Deckner & Blanton, 1980); post-test data indicated responding rose above baseline but some errors occurred in the final test (Mackay, 1985); or an adaptation was required for 1 subject in order to meet criterion (Smeets et al., 1984). In the Irvin (1976) investigation, training was stopped after 700 trials. Seven of the 24 subjects did not meet criterion with this amount of training.

Efficiency

All of the studies reported at least one efficiency measure. The most frequently reported measures included errors to criterion (e.g. Lancioni, 1983; Lancioni et al., 1984; McIlvane et al., 1984) and trials to criterion (e.g. Deckner & Blanton, 1980; LaVigna, 1977; Smeets et al., 1985). Additional measures included sessions to criterion (Deckner & Blanton, 1980; Goetz et al., 1983), days to criterion (Lancioni, 1983), and training time (Smeets et al., 1984). Seven of the studies, including both stimulus shaping and fading, reported error measures which indicated a low number of errors (Lancioni, 1983; Lancioni et al., 1984; LaVigna, 1977; Mackay, 1985; McIlvane et al., 1984; Smeets et al., 1985; Smeets et al., 1984). Lancioni et al. (1984) stated that "error rates during training were quite low" (p. 119), and Mackay (1985) reported that "errors were rare on teaching program trials" (p. 380).

Summary

Based on the literature reviewed, the following statements can be made:

* Stimulus manipulation procedures have been conducted with subjects who have mild to profound mental retardation, autism, or multiple handicaps; secondary-aged subjects were the most frequently used age-population in the studies.

* Instructional materials were the stimuli manipulated in all but one of the studies.

* More stimulus shaping studies existed in the literature than stimulus fading studies.

* All behaviors taught were discrete tasks.

* Relevant dimensions that were manipulated in stimulus shaping studies included intensity, size, shape, position, distance, and number.

* Irrelevant dimensions that were added and faded in stimulus fading studies included intensity, size, and color.

* All studies indicated a criterion level that must be attained by the subject before moving to the next step in the sequence.

* Five of eleven studies reported procedures for returning to previous steps in the sequence following errors.

* Most studies corrected subjects' errors by providing the subject with additional information or instructions, or guiding the subject to perform the correct behavior.

* The majority of stimulus manipulation procedures were effective in teaching the targeted behavior.

* The most commonly reported efficiency measures were errors and trials to criterion.

* Seven of eleven studies reported near errorless responding using both stimulus shaping and stimulus fading procedures.

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Comparative Studies

Chapter 11

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In this document, instructional strategies used to teach a variety of behaviors were analyzed and described. Studies comparing two or more instructional strategies in terms of their relative effectiveness and/or efficiency also appeared in the literature. Billingsley and Romer (1983) reviewed studies which compared the prompt fading procedures of decreasing assistance, graduated guidance, time delay, and increasing assistance. The authors identified only six studies. Schoen (1986) also reviewed comparison studies with the same procedures, and included the instructional procedures of stimulus fading and stimulus shaping. This section expands on the above reviews and includes studies which systematically compared one or more of the following instructional strategies: constant time delay, progressive time delay, most-to-least assistance, system of least prompts, antecedent prompt and fade, antecedent prompt and test, incidental teaching, stimulus fading, stimulus shaping, and error correction procedures.

Types of Comparison

Of the 27 comparative studies reviewed, 15 compared two procedures (e.g. Ellis, Walls, & Zane, 1980; Godby, Gast, & Wolery, in press; Neef, Walters & Egel, 1984), seven compared three (e.g. McGee & McCoy, 1981; Richmond & Bell, 1983; Strand & Morris, 1986; Walls, Zane & Thvedt, 1980), and five studies compared four procedures (Dorry, 1976; Haught, Walls, & Crist, 1984; Walls, Dowler, Haught, & Zawlocki, 1984; Zane, Walls, & Thvedt, 1981; Zawlocki & Walls, 1983). Of these studies, two compared a single instructional strategy with "integrations of assistance procedures" (Schoen, 1986, p. 68), or procedures which combine more than one instructional strategy (Irvin & Bellamy, 1977; Mosk & Bucher, 1984). Irvin and Bellamy (1977) for example, taught an assembly task to subjects with severe retardation using stimulus shaping, stimulus fading, and a combined shaping and fading procedure. Mosk and Bucher (1984) taught students with moderate and severe handicaps to put pegs in a pattern on a pegboard and hang up washcloths and toothbrushes. In both of the experiments in their study, the system of least prompts was compared with system of least prompts plus stimulus shaping. The majority of the studies in this review compared stimulus manipulation procedures with another instructional strategy (e.g. Dorry 1976; Schreibman, 1975; Wolfe & Cuvo, 1978), or compared error correction with another strategy (e.g. Ellis et al., 1980; McGee & McCoy 1981; Zane et al. 1981). A description of the subjects, settings, behaviors, results, and experimental designs that were involved in the investigations using stimulus manipulation procedures are shown in Table 1; codes for information presented in Table 1 are found in Appendix A. The behaviors and strategy specific information are shown in Table 2.

Results from Investigations Comparing Two or More Strategies

Citation	Population Number/ Gender	Age	Diag- nosis	Setting	Behavior	Effective- ness	Efficiency	Generali- zation	Mainten- ance	Design
Ault (1985)	2M 1F	8.1- 11.3	MoMR	PS	Community sign reading	S1+ S2+	T E M S S1=S2	PS+ T+/-	+/-W	PT
Strategy 1 - PTD; Strategy 2 - CTD										
Bennett et al. (1986)	1M 2F	14- 17	MoMR SMR HI VI	PS	Manual signing	S1+ S2+	T E M S S1<S2	N/D	N/D	PT
Strategy 1 - PTD; Strategy 2 - SLP										
Cavallaro & Bambara (1982)	1M	5.2	DD SLI	CS	Two-word requestion	S1>S2	N/D	T-	N/D	AT
Strategy 1 - Incidental teaching; Strategy 2 - Question-label										
Csapo (1981)	5M 1F	12- 16	SMR PMR	IN	Recept. color id. id.	S1>S2	E S1<S2	N/D	N/D	ABA
Strategy 1 - SLP; Strategy 2 - Most-least										
Dorry (1976)	32M 16F	11.8- 36.4	MoMR SMR	IN	Word reading	S1>S3 S3>S4 S4>S1	E	N/D	S1+/- S2+/- S3+/- S4+/-	Gr
Strategy 1 - Fade word in; Strategy 2 - Fade picture out; Strategy 3 - Double-fade; Strategy 4 - Standard										
Ellis et al. (1980)	12M 11F	18- 50	MiMR HI	CS	Apparatus assembly	N/A	E,S1<S2 M,S1=S2 T,S2<S1 but S1 had a mandatory number of trials	N/D	+/-W S1=S2	Gr
Strategy 1 - Preresponse; Strategy 2 - Error Correction										
Glendenning et al. (1983)	5M 7F	16- 20	MoMR SMR	PS	Tying string on box	N/A	S2>S1	N/D	N/D	Gr
Strategy 1 - SLP sequence; Strategy 2 - Most-least sequence; Strategy 3 - Most-least sequence										

Table 1 Continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs.	Diagnosis							
Godby et al. (in press)	1M 2F	8.3-16	Aut SMR MH	PS	Recept. object id.	S1+ S2+	S T E M S1<S2	N/D	N/D	Gr
Strategy 1 - PTD; Strategy 2 - SLP										
Haught et al. (1984)	15M 6F	18-44	MiMR MoMR	CS	Apparatus assembly	N/A	E S1,S3<S2,S4 M S1,S2<S3,S4	N/D	N/D	Gr
Strategy 1 - Short task - preresp.; Strategy 2 - Short task - Error Corr.; Strategy 3 - Long task-Preresp.; Strategy 4 - Long task-Error Correction										
Irvin & Bellamy (1977)	51N/D	$\bar{X}$= 23-25	SMR	IN	Apparatus assembly	S3>S2>S1	TE S3<S2<S1	N/D	N/D	Gr
Strategy 1 - Stimulus shaping; Strategy 2 - Stimulus fading; Strategy 3 - Combined shaping/fading										
McGee et al. (1985)	3M	6-11	Aut	SS	Express. labeling of prepositions	+/- S1=S2	M S1=S2	P,S+/- S2>S1 T,S2>S1	N/D	MB
Strategy 1 - Error Correction; Strategy 2 - Incidental teaching										
McGee & McCoy (1981)	4M	18.5-22.5	MoMR	CS	Word reading	S2,S3>S1	E S2<S3<S1 T S1<S3<S2	N/D	+/-D S2,S3>S1	MB
Strategy 1 - Error Correction; Strategy 2 - Stim. fading; Strategy 3 - PTD										
Mosk & Bucher (1984) Exper I	4M 2F	1.8-6.1	MoMR SMR	SS	Placing pegs in pegbd.	S2+ S1+/-	E S2<S1 P/U S2<S1 T S2<S1	P+/- S+/-	N/D	AT
Exper 2	4M 2F	2.5-9.9	MoMR SMR	SS	Hang items on peg	S2>S1	ES2<S1 P/U S2<S1	P+/- S+	N/D	AT
Strategy 1 - SLP; Strategy 2 - Stim. shaping and SLP										

Table 1 Continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs.	Diagnosis							
Neef et al. (1984)	3M 1F	4-6	Aut DD	PS	Yes/No response	S1- S2+	N/D	T+/m	N/D	MB
Strategy 1 - Error Correction; Strategy 2 - Incidental teaching										
Precious (1985)	4M	7.2-8.10	LD	PS	Sight word reading	S1+ S2+	T,E,M S1=S2	SP+ T+	N/D	PT
Strategy 1 - PTD; Strategy 2 - CTD										
Richmond & Bell (1983)	10M 5F	16-55	PMR	IN	Discrim. of circles	+/-	E S1<S2<S3	N/D	N/D	N/D
Strategy 1 - Stim. shaping; Strategy 2 - Prompt-fade; Strategy 3 - Error correction										
Rynders et al. (1979)	20 2M:1F	3	DD	N/D	Items on assessment	+/- S2>S1	P/U,E S1=S2	N/D	N/D	Gr
Strategy 1 - SLP; Strategy 2 - Error correction										
Schreibman (1975)	4M 2F	8.6-14.0	Aut	IN	Visual/ Auditory discrimin.	S1- S2+/-	E S2<S1	N/D	N/D	N/D
Strategy 1 - Most-least; Strategy 2 - Stim. shaping										
Strand & Morris (1986)	12M 9F	7.1-14.8	SMR	SS	Visual discrimin.	S1+ S2+ S3+/-	E,T S1;S2<S3 S1=S2	N/D	N/D	Gr
Strategy 1 - Most-least; Strategy 2 - Stim. fading; Strategy 3 - Error correction										
Thomas (1986)	1M 2F	7-9	LD	PS	Sight word reading	S1+ S2+	S,E,M S1=S2	T+	N/D	PT
Strategy 1 - PTD; Strategy 2 - CTD										
Walls et al. (1981)	9M 5F	16-50	MiMR MoMR	CS	Fold shirts; Set table; Use tape player	N/A	E,M S1=S2=S3	N/D	N/D	Gr
Strategy 1 - SLP sequence; Strategy 2 - Most-least sequence; Strategy 3 - Most-least sequence										

Table 1 Continued.

Citation	Population			Setting	Behavior	Effectiveness	Efficiency	Generalization	Maintenance	Design
	Number/ Gender	Age/ Yrs.	Diagnosis							
Walls et al. (1984)	12M 7F	19-56	MiMR N	CS	Apparatus assembly	N/A	E S2:S3:S4:<S1 P/U S3:S4<S1:S2 M S1;S2<S3:S4	N/D	N/D	Gr
Strategy 1 - Whole task-Error Corr.; Strategy 2 - Whole task-PTD; Strategy 3 - Forward chain-Error Corr.; Strategy 4 - Forward chain-PTD										
Walls et al. (1980)	6M 6F	23-29	MoMR SMR	CS	Apparatus assembly	S1+/- S2+ S3+	M S1=S2=S3 E Bkwd<Total Preresp<EC	N/D	N/D	MB
Strategy 1 - Personal method; Strategy 2 - Whole task-Error Corr.; Strategy 3 - Backward chain-Preresponse										
Walsh & Lamberts (1979)	15M 15F	$\bar{X}$= 12.4	MoMR	PS	Sight word reading	S2>S1	N/D	T S2>S1	N/D	RM Gr
Strategy 1 - Stim. fading; Strategy 2 - Stim. shaping										
Wolfe & Cuvo (1978)	19M 5F	$\bar{X}$= 21.10	SMR	IN	Recept. letter id.	S2>S1	T S2<S1	N/D	+/-W	Gr
Strategy 1 - Most-least; Strategy 2 - Stim. shaping										
Zane et al. (1981)	9M 3F	19-45	MoMR SMR	CS	Apparatus assembly	+/-	M S3<S1:S2:S4 E S1<S2:S3:S4 P/U S3:S4<S1:S2	N/D	N/D	RM
Strategy 1 - Backward chain-Preresponse; Strategy 2 - Backward chain-Error Corr.; Strategy 3 - Total task-Preresponse; Strategy 4 - Total task-Error Corr.										
Zawlocki et al. (1983)	6M 6F	18-41	MiMR MoMR	CS	Visual discrim.	N/A S1,S2, S3>S4	E S1=S2=S3 S1,S2,S3<S4	N/D	N/D	Gr
Strategy 1 - Stim. shaping on S+; Strategy 2 - Stim. shaping on S-; Stratgey 3 - Stim. shaping on S+ and S-; Strategy 4 - Error correction										

Table 2

Methods from Investigations Comparing Two or More Strategies

Citation	Population Number/Diag.		Behavior Name	Behavior Type	Procedures	Consequences Correct Responses	Consequences Error Responses
Ault (1985) Strategy 1 PTD	3	MoMR	Community sign reading	DS	MO prompt: 1 sec. delay increase each session: Maximum 8 sec. delay	descriptive verbal praise, token	VR, 10 sec. inseat timeout
Strategy 2 CTD					MO prompt: 5 sec. delay increase each session: Maximum 5 sec. delay.	descriptive verbal praise, token	VR, 10 sec. in-seat timeout
Bennett et al. (1986) Strategy 1 PTD	3	MoMR SMR VI	Manual signing	DS	MO prompt: 1 sec. delay increase each session: Maximum 10 sec. delay	descriptive verbal praise, edibles	10 sec. in-seat timeout
Strategy 2 SLP		HI			5 prompt levels: SD/SD, VI/SD, MO/SD, PP/SD, FP. 5 sec. response interval.	descriptive verbal praise, edibles	Present next prompt level; If error after FP, then 10 sec. timeout
CODES	See Appendix A		See Appendix A	Ch = chained DS = discrete	I = independent VI = verbal instruction G = gesture MO = model VP = visual prompt PP = partial physical FP = full physical manipulation SD = discriminative stimulus SLP = system of least prompts S+ = correct stimulus S- = incorrect stimulus S = subject N/D = not defined	CRF = continuous reinforcement VR = variable reinforcement MO = model N/D = not defined	VR = verbal reprimanc MO = model VI = verbal instruction IVI = indirect verbal instruction FP = full physical manipulation NR = no response N/D = not defined

Table 2 continued.

Citation	Population Number/Diag.		Behavior Name	Type	Procedures	Consequences Correct Responses	Error Responses
Cavallaro & Bambara (1982)							
Strategy 1 Incidental teaching	1	DD SLI	Two-word requesting	DS	S initiated then 4 prompt levels: G/VI/MO/MO. Response interval 3 sec.	praise, present object requested	present next prompt level: If incorrect after 2nd model presented object anyway
Strategy 2 Question-label					Described objects, events in the environment. Asked questions. Never required S to respond to gain materials.	None	None
Csapo (1981)							
Strategy 1 SLP	6	SMR PMR	Fluency in recept. color identification	DS	4 prompt levels: I/MO/PP/FP. 3 sec. response interval. If 3 correct at one level, reinforce for corrects at decreased level of prompting.	praise, edibles CRF	N/D
Strategy 2 Most-least					4 prompt levels: FP/PP/G/I. 3 corrects, move to next level.	praise, edibles CRF	N/D
Dorry (1976)							
Strategy 1 Fade word in	48	MoMR SMR	Word reading	DS	Picture was visible, word gradually faded in.	verbal praise edible	VR
Strategy 2 Fade picture out					Picture and word visible, picture gradually faded out.	verbal praise edible	VR
Strategy 3 Double-fade					Simultaneously faded word in and picture out.	verbal praise edible	VR
Strategy 4 Standard					Word and picture paired without fading.	verbal praise edible	VR

Citation	Population		Behavior		Procedures	Consequences	
	Number/Diag.		Name	Type		Correct Responses	Error Responses
Ellis et al. (1980) Strategy 1 Preresponse	23	MiMR HI	Apparatus assembly	Ch	Model preceded response	verbal praise	MO. trial repeated
Strategy 2 Error Correction					Model followed error	verbal praise	MO
Glendenning et al. (1983) Strategy 1 SLP sequence	12	MoMR SMR	Tying string on box	Ch	VI/G/MO/FP	N/D	Reprompted response
Strategy 2 Most-least sequence					VI,FP/VI,PP/VI,G/VI	N/D	Reprompted response
Strategy 3 Most-least sequence					FP/Moderate phys. assist./ light phys. assist./G	N/D	Reprompted response
Godby et al. (in press) Strategy 1 PTD	3	Aut SMR MH	Recept. object id.	DS	MO prompt; 1 sec delay increase each session. Maximum 7 sec. delay.	descriptive verbal praise, edibles	10 sec. in-seat timeout
Strategy 2 SLP					5 prompt levels: I/G/MO/PP/FP. 5 sec. response interval.	descriptive verbal praise edibles	present next prompt level

Table 2 continued.

Citation	Population Number/Diag.		Behavior Name	Type	Procedures	Consequences Correct Responses	Error Responses
Haught et al. (1984)							
Strategy 1 Short task - Preresp.	21	MiMR MoMR	Apparatus assembly	Ch	MO preceded response (6 parts)	N/D	MO, then FP if needed
Strategy 2 Short task - Error Corr.					MO followed error (6 parts)	N/D	MO, then FP if needed
Strategy 3 Long task - Preresp.					MO preceded response (12 parts)	N/D	MO, then FP if needed
Strategy 4 Long task -					MO followed error (12 parts)	N/D	MO, then FP if needed
Irvin & Bellamy (1977)							
Strategy 1 Stimulus shaping	51	SMR	Discrim. of nut faces	DS	Raised vs. flat side of nut. Raised side of nut was exaggerated, decreased height of raised side.	social, verbal praise	Verbal, full or faded prompts used as needed.
Strategy 2 Stimulus fading					Added color to raised side. Color intensity gradually faded.	social, verbal praise	Verbal, full or faded prompts used as needed.
Strategy 3 Combined Shaping/fading					Combined both procedures and faded.	social, verbal praise	Verbal, full or faded prompts used as needed.
McGee et al. (1985)							
Strategy 1 Error Correction	3	Aut	Express labeling of prepositions	DS	Presented materials and SD. Seated at table.	descriptive praise, 5 sec. access to materials.	MO
Strategy 2 Incidental teaching					Materials on shelves. When S requested item, the SD was presented.	descriptive praise, 5 sec. access to materials.	MO

Table 2 continued.

Citation	Population		Behavior		Procedures	Consequences	
	Number/Diag.		Name	Type		Correct Responses	Error Responses
McGee & McCoy (1985) Strategy 1 Error Corr.	4	MoMR	Word reading	DS	Word presented for 10 sec. then picture superimposed on word.	illumination of light CRF: tokens VR3	N/D
Strategy 2 Stim. fading					Picture and word presented simultaneously: picture intensity gradually decreased After correct, decrease picture intensity 1 step.	illumination of light CRF: tokens VR3	N/D
Strategy 3 PTD					VP: 1 sec delay increase each correct response. Maximum 5 sec delay.	illumination of light CRF: tokens VR3	N/D
Mosk & Bucher (1984) Experiment 1 Strategy 1 SLP	6	MoMR SMR	Placing pegs in pegboard	DS	5 prompt levels: I/I,G/I,MO/I,PP I,FP. 5 sec. response interval	edible CRF	Present next prompt level
Strategy 2 Stim. shaping + SLP					SLP prompts and gradually added S-	edible CRF	Present next prompt level
Experiment 2	6	MoMR SMR	Hang items on peg	DS	Same comparisons as above	N/D	N/D

Table 2 continued.

Citation	Population		Behavior		Procedures	Consequences	
	Number/Diag.		Name	Type		Correct Responses	Error Responses
Neef et al. (1984)							
Strategy 1 Error Corr.	4	Aut DD	Yes/No response	DS	S labeled object, then yes/no (SD) was presented	descriptive praise and edible or tangible	NO, repeat SD until correct response occurred.
Strategy 2 Incidental teaching					S initiated request, then yes/no (SD) who presented	Yes questions- descriptive praise, delivery of item	Yes questions- withhold item, wait 1 sec, repeat question, prompt correct response.
						No questions- descriptive praise, delivery of selected item	No questions- offer item, repeat question, prompt correct, and deliver item
Precious (1985)							
Strategy 1 PTD	4	LD	Sight word reading	DS	MO prompt: 1 sec. delay increase each block of 10 trials. Maximum 7 sec. delay.	verbal praise	VR, 10 sec in-seat timeout
Strategy 2 CTD					MO prompt: 3 sec. delay increase after 1st block of 10 trials. Maximum 3 sec. delay	verbal praise	VR, 10 sec in-seat timeout
Richmond & Bell (1983)							
Strategy 1 Stim. shaping	15	PMR	Size discrim. of circles	DS	Size of S- was gradually increased over 12 trials.	Verbal praise, edible	VR, remove materials
Strategy 2 Prompt-fade					Point prompt. The proximity of the point to the S+ was gradually decreased.	verbal praise, edible	VR, remove materials
Strategy 3 Error Corr.					S+ and S- at criterion levels throughout instruction.	verbal praise, edible	VR, remove materials

Table 2 continued.

Citation	Population		Behavior		Procedures	Consequences	
	Number/Diag.		Name	Type		Correct Responses	Error Responses
Rynders et al. (1979)							
Strategy 1 SLP	20	DD	Items on assessment	DS	4 prompt levels: I/VI/VI.MO/VI.FP	N/D	present next prompt level
Strategy 2 Error Corr.					Presented SD and waited 15 sec. or 30 sec. for correct response.	N/D	VI up to 3 times if needed
Schreibman (1975)							
Strategy 1 Most-least	6	Aut	Visual/ auditory discrim.	DS	Visual task - Proximity of point prompt to S+ was gradually decreased. Aud. task - Paired buzzer with S+ Volume of buzzer faded.	Verbal praise, edibles	VR remove materials
Strategy 2 Stim. shaping					Visual task - Size and position prompts were faded out. Redundant components were faded in. Aud. task - Redundant components faded in. Volume intensity gradually increased.	Verbal praise, edibles	VR remove materials
Strand & Morris (1986)							
Strategy 1 Most-least	21	SMR	Visual discrim.	DS	8 prompt levels: VI, G, FP/fade out prompts over 8 levels. Levels N/D.2 corrects, move to next step.	computer tunes, verbal praise, edible	If incorrect score error. If NR-IVI. If still NR-score error.
Strategy 2 Stim. shaping					Faded in intensity of S-: 2 corrects, move to next step.	computer tunes, verbal praise, edible	If incorrect score error. If NR-IVI. If still NR score error.
Strategy 3 Error Corr.					Stimuli presented.	computer tunes, verbal praise, edible	If incorrect score error. If NR-IVI. If still NR score error.

Table 2 continued

Citation	Population Number	Diag.	Behavior Name	Behavior Type	Procedures	Consequences Correct Responses	Consequences Error Responses
Thomas (1986)							
Strategy 1 PTD	3	LD	Sight word reading	DS	MO prompt: 1 sec. delay increase each session. Maximum 6 sec. delay	verbal praise	VR
Strategy 2 CTD					MO prompt: 3 sec. delay increase after 1st session. Maximum 3 sec. delay.	verbal praise	VR
Walls et al. (1981)							
Strategy 1 SLP sequence	14	MiMR MoMR	Fold shirts: Set table: Use tape player	Ch	4 prompt levels: I/VI/MO/FP	verbal praise	N/D
Strategy 2 Most-least sequence					4 prompt levels: I/FP/MO/VI	verbal praise	N/D
Strategy 3 Most-least sequence					4 prompt levels: I/FP/PP/Slight physical prompt	verbal praise	N/D
Walis et al. (1984)							
Strategy 1 Whole task-Error corr.	19	MiMR N	Apparatus assembly	Ch	First trial-MO given before each response in task. Thereafter, no MO and given as much time as needed to complete response.	verbal praise	VR, MO, require correct response
Strategy 2 Whole task-PTD					First trial-same as above. 1 sec. delay increase each correct response.	verbal praise	VP. MC. require correct response
Strategy 3 Forward chain-Error corr.					New part of task only added after correct response. Given as much time as needed to complete response.	verbal praise	VR, MO, require correct response
Strategy 4 Forward chain-PTD					New part added only after anticipation. 1 sec. delay increase each correct response.	verbal praise	VR, MO, require correct response

Citation	Population Number/Diag.		Behavior Name	Behavior Type	Procedures	Consequences Correct Responses	Consequences Error Responses
Walls et al. (1980)							
Strategy 1 Personal method	12	MoMR SMR	Apparatus assembly	Ch	Trainers taught however they wished.	Varied	Varied
Strategy 2 Whole task-Error corr.					MO entire task-then disassembled and presented to S.	Social praise	VR. MO. description. FP
Strategy 3 Backward chain-Preresponse					MO entire task, disassembled, last part and provided MO, description, FP, then S performed.	Social praise	VR. MO
Walsh & Lamberts (1979)							
Strategy 1 Stim. fading	30	MoMR	Sight word reading	DS	Word and picture presented simultaneously, picture gradually faded.	N/D	VR. MO S repeat MO
Strategy 2 Stim. shaping					Began with grossly dissimilar stimuli and gradually manipulated letters until stimuli more similar to target word.	N/D	VR. MO S repeat MO
Wolfe & Cuvo (1978)							
Strategy 1 Most-least	24	SMR	Recept. letter id.	DS	Point prompt, 3 prompt levels each increases distance of point from S+. 8/10 correct at each level, give probe trials.	praise, choice of reinforcer from tray	incorrect-VR, remove stimuli NR-"Let's try another one"
Strategy 2 Stim. shaping					Lines of letters thickened, gradually decrease thickness and height of lines.	praise, choice of reinforcer from tray	incorrect-VR, remove stimuli NR-"Let's try another one".

Table 2 continued.

Citation	Population		Behavior		Procedures	Consequences	
	Number/Diag.		Name	Type		Correct Responses	Error Responses
Zane et al. (1981)							
Strategy 1 Backward chain-Preresponse	12	MoMR SMR	Apparatus assembly	Ch	MO then S performed. When no errors, another part removed and modeled.	Verbal praise	VR, FP
Strategy 2 Backward chain-Error corr.					No MO given before response	Verbal praise, MO	VR, FP
Strategy 3 Total task-Preresponse					MO before each step in task analysis. Then S performed.	Verbal praise	VR, FP
Strategy 4 Total task-Error corr.					No MO given: all parts presented.	verbal praise, MO	VR, FP
Zawlocki et al. (1983)							
Strategy 1 Stim. shaping on S+	12	MiMR MoMR	Visual discrim.	DS	Size of S+ circle gradually faded.	"Yes"	VR
Strategy 2 Stim. shaping on S-					Numerosity of S - was gradually increased.	"Yes"	VR
Strategy 3 Stim. shaping on S+ and S-					Size faded simultaneously on S+ and S-; Numerosity faded simultaneously on S+ and S-.	"Yes"	VR
Strategy 4 Error corr.					Stimuli were at criterion levels.	"Yes"	VR

Behavior/Popluation

Behaviors that were taught in these studies included expressive language skills (Bennett, Gast, Wolery, & Schuster, 1986; Cavallaro & Bambara, 1982; McGee, Krantz, & McClannahan, 1985; Neef et al., 1984), receptive language skills (Godby, Gast, & Wolery, in press), discrimination tasks (Csapo, 1981; Richmond & Bell, 1983; Schreibman, 1975; Strand & Morris, 1986; Zawlocki & Walls, 1983), daily living skills (Walls, Crist, Sienicki, & Grant, 1981), self-help skills (Mosk & Bucher, 1984; Rynders, Behlen, & Horrobin, 1979), vocational skills (Ellis et al., 1980; Glendenning, Adams, & Sternberg, 1983; Haught et al., 1984; Irvin & Bellamy, 1977; Walls et al., 1984; Walls et al., 1980; Zane et al., 1981), and cognitive skills such as reading (Ault, 1985; Dorry, 1976; McGee & McCoy, 1981; Precious, 1985; Thomas, 1986; Walsh & Lamberts, 1979), visual-motor tasks (Mosk & Bucher, 1984), preacademic items on an assessment tool (Rynders et al., 1979), and letter discrimination (Wolfe & Cuvo, 1978). The majority of these investigations taught discrete behaviors (e.g. Csapo, 1981; Walsh & Lamberts, 1979; Wolfe & Cuvo, 1978), while eight of the studies taught chained tasks. These chained tasks included all of the vocational behaviors and daily living skills (e.g., Ellis et al., 1980; Walls et al., 1981; Zane et al., 1981).

The populations that participated in these studies included persons with learning disabilities, mild to moderate retardation, autism, or multiple handicaps. Ages ranged from infants to adults with the majority being secondary-aged students or adults.

Results

Antecedent Prompting versus Error Correction

The most frequent comparison studied in the literature was an antecedent prompting procedure versus an error correction procedure to teach assembly skills (Ellis et al., 1980; Haught et al., 1984; Walls et al., 1980; Zane et al., 1981). Ellis et al. (1980), for example, taught 23 adults with mild mental retardation to assemble three apparatus. An antecedent prompting procedure in which a model was given before a trial, was compared with an error correction procedure, in which a model was given only after an error. Other comparisons were made in these studies in addition to the antecedent/error correction comparisons. For example, Haught et al. (1984) compared a short task with a long task; were both conducted with each procedure. Walls et al. (1980) compared a personal method (i.e., trainers were told to teach however they wanted), a structured whole method (i.e., an error correction procedure presented in a total task sequence), with a backward chaining method (i.e., a preresponse model procedure presented in a backward chaining sequence). Zane et al. (1981) compared a backward chaining sequence with a total task sequence conducted with each procedure.

Effectiveness. Three of these studies did not specify effectiveness measures but taught subjects with one procedure for a specific number of minutes then discontinued training at that time if criterion was not met (Ellis et al., 1980; Haught et al., 1984; Zane et al., 1981). The Walls et al. (1980) study stated that all procedures were effective except for one subject that did not meet criterion with the personal method.

Efficiency. In terms of efficiency all studies reported instructional time and error measures. Ellis et al. (1980) and Walls et al. (1980) both reported no significant differences between procedures in terms of instructional time. Zane et al. (1981) reported that the total task antecedent model procedure required less time than any of the other procedures. Haught et al. (1984) only stated that the short task took less time than the long task. In terms of errors during training, all studies reported that the antecedent model procedure produced fewer errors than the error correction procedure (Ellis et al., 1980); Haught et al., 1984; Walls et al. 1980; Zane et al., 1981).

Stimulus Modification versus Other Procedures

Ten of the studies compared some type of stimulus manipulation procedure with one or more other procedures. These comparisons included within-stimulus fading (i.e., stimulus shaping) versus extra-stimulus fading (i.e., most-to-least procedure) (Schriebman, 1975; Wolfe & Cuvo, 1978); stimulus shaping versus stimulus fading (Irvin & Bellamy, 1977; Walsh & Lamberts, 1979), stimulus shaping versus error correction (Zawlocki & Walls, 1983), stimulus shaping versus antecedent prompt and fade versus error correction (Richmond & Bell, 1983); superimposition and stimulus fading versus progressive time delay versus error correction (McGee & McCoy, 1981), stimulus fading versus most-to-least versus error correction (Strand & Morris, 1986), three kinds of stimulus fading versus a preresponse prompt that was not faded (Dorry, 1976), and stimulus shaping plus system of least prompts versus system of least prompts only (Mosk & Bucher, 1984).

Effectiveness. Schreibman (1975) and Wolfe and Cuvo (1978) both found that the stimulus shaping procedure was more effective than a most-to-least procedure in teaching visual/auditory discriminations and letter recognition, respectively. In the Strand and Morris (1986) study, both stimulus fading and most-to-least procedures were found to be more effective than an error correction procedure in teaching discrimination skills. Stimulus shaping was also more effective than stimulus fading in teaching sight word reading to students with trainable mental retardation (Walsh & Lamberts, 1979). Richmond and Bell (1983) found that all procedures (i.e., stimulus shaping, prompts and fade, error correction) were effective in teaching a size discrimination to adults with profound handicaps. In the Zawlocki and Walls (1983) investigation, error correction was not as effective as three stimulus shaping procedures in which the relevant dimension was faded on the S+, the S-, and the S+ and S- simultaneously. All shaping procedures resulted in increases in correct responding whereas the error correction procedure did not increase responding over chance levels. A combined stimulus shaping plus stimulus fading procedure was more effective than either procedure in isolation for teaching a bicycle axle assembly to adults with severe retardation (Irvin & Bellamy, 1977). Mosk and Bucher (1984) also found that the combined procedure of stimulus shaping plus system of least prompts was more effective than system of least prompts alone. McGee and McCoy (1981) reported mixed effectiveness results. Stimulus fading was most effective for two subjects, progressive time delay was most effective for one subject, and no difference in effectiveness between progressive delay and stimulus fading was found for one subject. The authors also reported that for all subjects, both fading and time delay were more effective than error correction. Subjects' history with either stimulus shaping or progressive time delay appeared to result in increased effectiveness of that procedure. In the Dorry (1976) study, word reading was taught to 48 adolescents and adults with mental retardation who had a mean IQ of 38. Four procedures taught sight word reading by pairing a picture the subject could identify with the target word. The procedures included: 1) fade-word-in condition - the picture was always visible and the word was faded in; 2) fade-picture-out condition - the word and picture were initially paired and the picture was gradually faded out; 3) double-fade condition - the word was gradually faded in while the picture was faded out; and 4) standard condition - the word and picture were always paired without fading. The percentage of correct responses to the word only was then tested. Results indicated the fade picture out was the most effective condition followed by the double fade, the standard, and finally the fade word in condition.

Efficiency. All of these studies, with the exception of Walsh and Lamberts (1979), reported some type of efficiency data. Number or percentage of errors was most frequently reported and was included in seven studies (e.g. Richmond & Bell, 1983; Schreibman, 1975; Strand & Morris, 1986), trials to criterion measure was reported by four (Irvin & Bellamy, 1977; McGee & McCoy, 1981; Mosk & Bucher, 1984; Strand & Morris, 1986), and one study reported number and percentage of prompts given (Mosk & Bucher, 1984). In the studies which reported error efficiency measures, stimulus shaping or stimulus fading produced a lower number or percentage of errors than most-to-least (Schreibman, 1975), system of least prompts (Mosk & Bucher, 1984), time delay or error correction (McGee & McCoy, 1981), and antecedent prompt and fade or error correction (Richmond & Bell, 1983). No significant differences existed between most-to-least and stimulus fading procedures in terms of number of errors, but both had less errors than the error correction procedure in teaching discriminations (Strand & Morris, 1986). The combined stimulus shaping and stimulus fading procedure used in the Irvin and Bellamy (1977) study produced less errors than the stimulus fading procedure, and stimulus fading resulted in fewer errors than stimulus shaping. Zawlocki and Walls (1983) did not report errors, but stated that fewer correct responses occurred in the error correction procedure than in any of the stimulus shaping conditions. Regarding the trials to criterion measure, stimulus shaping had fewer trials to criterion than a most-to-least strategy (Wolfe & Cuvo, 1978). Strand and Morris (1986) reported no significant differences in the number of trials between most-to-least and stimulus fading, but both procedures required less trials than error correction. Error correction had fewer trials followed by progressive delay and finally stimulus fading had the most trials in the McGee and McCoy (1981) investigation. Irvin and Bellamy (1977) reported that the combined stimulus manipulation procedures had the fewest trials to criterion followed by the stimulus fading procedure and then the stimulus shaping procedure.

Time Delay versus Other Procedures.

In addition to the McGee and McCoy (1981) study, progressive time delay was compared with the system of least prompts (Bennett et al., 1986; Godby et al., in press) and with an unlimited delay (i.e., error correction) procedure (Walls et al., 1984). Progressive delay was also compared with constant delay in teaching sight word reading to students with moderate retardation (Ault, 1985), and learning disabled subjects (Precious, 1985; Thomas, 1986).

Effectiveness. Both Bennett et al. (1986) and Godby et al. (in press) found that progressive time delay and system of least prompts were effective in teaching expressive manual signing and receptive object identification to students with moderate to severe retardation, respectively. Ault (1985), Precious (1985), and Thomas (1986) all found that both progressive and constant time delay were effective procedures in teaching word reading to elementary children.

Efficiency. Both Bennett et al. (1986) and Godby et al. (in press) found progressive time delay to be more efficient than the system of least prompts on the efficiency measures of sessions, trials, errors, and direct instructional time to criterion. Each of the progressive versus constant delay comparison studies found only slight differences in efficiency and so considered the two procedures to be equally efficient on the measures of sessions, trials, errors, and direct instructional time to criterion. Walls et al. (1984) compared progressive delay with error correction when each procedure was taught using a total task and forward chaining sequence. Nineteen adults with a mean IQ of 77.7 were taught to assemble four apparatus. Assembly was not trained to criterion but each procedure was used in training for a maximum of 75 minutes. The authors reported efficiency measures of number of errors, training time, and number of prompts. Error correction in a total task sequence had more errors than the other procedures. In addition, total task required more prompts and less training time than forward chaining.

System of Least Prompts versus Other Procedures

Not only has the system of least prompts procedure been compared to time delay and stimulus shaping, but it also was compared to a most-to-least procedure (Csapo, 1981; Glendenning et al., 1983; Walls et al., 1981), and to an error correction procedure (Rynders et al., 1979).

Effectiveness. Csapo (1981) found both procedures (system of least prompts, most-to-least prompts) were effective in building fluency with students who had severe and profound handicaps. Both Glendenning et al. (1983) and Walls et al. (1981) compared one prompt sequence arranged in a least-to-most order of assistance (i.e., system of least prompts), with two prompt sequences arranged in a most-to-least order of assistance. Neither study taught skills to criterion but stopped training after a specific number of trials or minutes so effectiveness data were not reported. Rynders et al. (1979) compared a system of least prompts procedure with an error correction procedure. Three-year-old children with down syndrome were compared to 3-year-old children without handicaps in solving preacademic tasks and self-help skills. The system of least prompts sequence (i.e., augmented instruction), consisted of the independent level, followed by verbal instruction, verbal instruction plus modeling, and verbal instruction plus manual guidance. Each prompt level was given contingent upon the subject not performing the task correctly. The error correction procedure (i.e., repeated verbal instruction) consisted of the subject being given the opportunity to perform, and contingent upon errors a verbal instruction was presented up to three times, if necessary. In terms of effectiveness, the authors stated that "despite either augmentative or repetitive verbal assistance, 36 to 42 percent of the problems remained unsolved by the Down's Syndrome children" (Rynders et al., 1979, p.72). The augmented instruction (system of least prompts), however, resulted in more problems being solved than the repeated verbal instruction procedure.

Efficiency. Csapo (1981) reported efficiency measures of errors per minute and mean increase of correct responses per minute. She stated that the system of least prompts was more efficient than the most-to-least procedure in building fluency of a color discrimination task. Walls et al. (1981) taught shirt folding, table setting, and use of a tape recorder. The authors found no efficiency differences between two most-to-least sequences and the system of least prompts sequence in terms of number of errors to criterion, number of seconds to criterion, and percentage of correct responses. Glendenning et al. (1983) compared three prompt sequences in teaching string tying which involved: Sequence One was verbal cue, gesture, model and full physical assistance; Sequence Two was verbal cue plus full physical assistance, verbal cue plus light physical assistance, verbal cue plus gesture, and verbal cue; and Sequence Three was full physical assistance, moderate physical assistance, light physical assistance, and gesture. In terms of efficiency, the authors examined the aspects of the prompt sequences. For example, a verbal prompt alone was found to be more effective when presented last in a sequence rather than first. However, no difference existed if full physical guidance was presented first or last in a sequence. A gesture prompt was found to be more efficient when preceded by verbal cues, and Sequence Two, which included verbal cues, was more efficient than no verbal cues in Sequence Three. Overall the authors state that "using the more-restrictive to less-restrictive prompt sequence appears to represent not only a more success-based approach but also an approach that would require less branching via correction steps" (Glendenning et al., 1983, p. 325).

Naturalistic versus Other Strategies

Effectiveness. Three studies in the literature were found which compared incidental teaching with either a "question-label" procedure (Cavallaro & Bambara, 1982) or with error correction procedures (McGee et al., 1985; Neef et al., 1984). Cavallaro and Bambara (1982) compared incidental teaching with a question-label procedure in teaching a 5-year-old child with developmental delays to use two-word requests. In the question-label procedure, the teacher asked questions and described objects in the environment, but the child was not required to speak before gaining access to materials. The incidental teaching procedure was more effective in teaching two word requests. When compared with error correction, incidental teaching was found to have no difference in effectiveness in teaching children with autism to expressively label prepositions (McGee et al., 1985). In the Neef et al. (1984) investigation, however, incidental teaching was effective whereas error correction was not in teaching yes/no responding to children with autism and severe handicaps.

Efficiency. The only efficiency measure found in these studies is reported by McGee et al. (1985) who stated that no significant difference in terms of training time existed between the two procedures.

Summary

Based on the literature reviewed, the following statements can be made:

- Comparative studies have been conducted with students with mild to profound handicaps, autism, and multiple handicaps.
- The majority of the studies were conducted with secondary-aged students or adults.
- Both chained and discrete tasks have been taught in these studies.
- Most studies compared two instructional strategies although up to four have been compared.
- Four out of 27 studies did not report efficiency measures (Cavallaro & Bambara, 1982; Neef et al., 1984; Rynders et al., 1979, Walsh & Lamberts, 1979).
- The most frequently reported efficiency measure was errors to criterion or errors during training.
- An antecedent model procedure produced fewer errors than error correction procedures.
- Procedures using stimulus shaping or stimulus fading had less errors than a most-to-least procedure, system of least prompts, time delay, error correction, or an antecedent prompt and fade procedure.

- Mixed results exist for effectiveness and efficiency when the system of least prompts is compared to the most-to-least prompting procedure.
- Progressive delay was more efficient than system of least prompts in terms of number of sessions, errors, trials, and training time to criterion.
- Progressive and constant time delay appear to be equally effective and efficient. However, with some students efficiency differences exist, but no predictor variables could be identified to determine which of the two delay procedures would be more efficient with which students.
- In some cases, incidental teaching appears to be more effective than error correction.
- Integrated strategies appeared to be more effective than single strategies used alone.

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Summary Statements and Recommendations

Chapter 12

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This document is a review of articles that investigated instructional strategies used with persons whose handicaps were moderate and severe. As noted in the introduction, a strategy was defined as a replicable, systematic approach for providing instruction that addressed both antecedent and consequent events. Since the review focused on strategies, instructional variables common across strategies, the content of instruction, and many other issues were not addressed. In short, this is not the "last word" on teaching; it is a synthesis and description of strategies that are used while teaching.

Ideally, the summary chapter of a document such as this would provide clear statements telling practitioners, "if you want to teach a given behavior to a particular student who has the following prerequisite behaviors, then you should use such and such strategy." Unfortunately, the current data base does not allow such recommendations. Strategy by skill, strategy by population, and strategy by setting recommendations are not possible. However, in each of the preceding chapters, summary statements about the literature were made. This chapter focuses on (a) summary statements that can be made across the strategies, (b) identification of issues for further research, and (c) guidelines for selecting instructional strategies.

Across-Strategy Summary Statements

1. Reports exist attesting to the effectiveness of each strategy with a variety of behaviors and students. This statement has both positive and negative aspects. Apparently, less than a dozen separate instructional strategies can be used to teach almost any behavior to a wide variety of

students in different settings. This finding suggests that teacher preparation programs should ensure that their students can competently perform these strategies. Given this small number, the task of teacher preparation should be manageable. However, two qualifications must be noted. First, although some subjects in many studies performed better than others, there were few reports of total failures in the literature. Given the presence of the educability debate (Baer, 1981; Baumeister, 1981; Kauffman, 1981), however, it is clear that the strategies are not universally effective. If they were totally effective, then the educability debate would be solved. Second, variations in the implementation of the strategies can influence their effectiveness and efficiency. Examples include the types of instructional modifications discussed in the first chapter (e.g., using distributed rather than spaced trials, presenting stimuli concurrently rather than serially, requiring an active attending response, using response-related reinforcers, and many others). Simply using the strategies as they have been described does not ensure effectiveness nor efficiency. The teacher must attend to the environmental conditions in which instruction occurs, the behaviors being taught, the manner in which stimuli and assistance are provided, and the feedback given for students' responses.

2. Relatively few replication studies assessing the procedural parameters of the strategies exist. While the need for replication may exist in nearly all areas of research, the instructional strategy literature appears to suggest a need for a particular type of replication study: those that assess variations in the procedural parameters of the strategies. Such studies would allow investigators to systematically vary components of the strategies and assess their relative effectiveness and efficiency. As noted above, numerous reports

exist concerning the effectiveness of the strategies; however, those studies infrequently contain systematic variations of earlier studies. Thus, the differences in effectiveness or efficiency could not be attributed to specific variables in the latter studies. Without such studies, an empirical technology of instruction will not be developed.

3. The literature on instructional strategies was primarily developed using students who were upper-elementary age, secondary age, and adults. Across nearly all of the strategies, the majority of the investigations were conducted using subjects who were at least 12 years of age. Thus, a considerable need exists for assessing the effectiveness and efficiency of the strategies with younger populations.

4. Most studies occurred in public schools or in institutional settings. Although studies occurred in settings such as special schools, preschool centers, and in the community, the majority of the studies were in public school and institutional settings. Since these are frequently the primary educational environments of many students, it appears that the instructional strategies literature has been conducted in applied settings.

5. Many of the investigations targeted discrete rather than chained responses. Discrete responses are those which are brief and involve one behavior rather than a series or sequence of behaviors. Chained responses are those that involve a number of behaviors which, when performed in a specific sequence, are classified as a skill, task, or complex behavior. For example, many of the articles addressed discrete responses such as naming (pictures, objects, etc.), matching, or pointing to instructional stimuli. Fewer of the articles focused on skills such as toothbrushing, dressing, self-feeding, making a meal, or assembling an apparatus. Unfortunately, many of the

behaviors that are considered useful or practical by teachers and parents are classified as chained tasks. It appears that the knowledge of instructional strategies is, in large part, a body of information related to teaching discrete behaviors; the possible exception is the system of least prompts where a majority of the behaviors taught were chained responses. Thus, when teaching chained responses, the current literature would suggest using the system of least prompts.

6. The behaviors targeted in the investigations were, for the most part, socially valid responses. Because the review attempted to focus on applied studies, this finding may be an artifact of the methods used. However, it is clear that across strategies there was a tendency for the stimulus modification strategies to deal with less applied behaviors than were found with other instructional procedures. Further, it is clear that a large body of knowledge about teaching applied behaviors exists.

7. Relatively few studies exist where two or more of the instructional strategies were directly compared. Only 27 studies were found that compared two or more of the instructional strategies; the comparisons that have been made are shown in Table 1. As can be seen, error correction has been compared most frequently to other instructional strategies followed by the stimulus modification procedures (stimulus shaping and fading) and the system of least prompts. The antecedent prompt and fade procedure, constant time delay, and naturalistic teaching procedures are the three strategies receiving the least attention in the comparative literature. Given current trends to use naturalistic procedures, this lack of comparative research is striking.

Table 1

Number of Studies that have Compared Two or More Instructional Strategies[a]

Instructional Strategies	Instructional Strategies[b]											
	EC	APT	APF	MTL	SLP	CTD	PTD	NT	SF	SS	IPS	Total
Error Correction	XXXXXX XXXXXX XXXXXX	4	1	1	1		2	2	2	2		15
Antecedent Prompt and Test	4	XXXXXXX XXXXXXX XXXXXXX						1	1			6
Antecedent Prompt and Fade	1		XXXXXX XXXXXXX XXXXXXX							1		2
Most-to-Least Prompting	1			XXXXXXX XXXXXXX XXXXXXX	3				1	2		7
System of Least Prompts	1			3	XXXXXXX XXXXXXX XXXXXXX	0	2			1	1	8
Constant Time Delay						XXXXXXX XXXXXXX XXXXXXX	3					3
Progressive Time Delay	2				2	3	XXXXXXX XXXXXXX XXXXXXX		1			8
Naturalistic Teaching	2	1						XXXXXX XXXXXX XXXXXX				3
Stimulus Fading	2	1		1			1		XXXXXX XXXXXX	3	1	9
Stimulus Shaping	2		1	2	1				3	XXXXX XXXXX	1	10
Integrated Prompting Systems					1				1	1	XXXXXX XXXXXX XXXXXX	3

[a] Cells with "X's" indicate those where a comparison is not possible (i.e., comparison of a strategy to itself); numbers to the lower-left of the "X's" are redundant with those to the upper-right; blank cells indicate the comparisons that have not occurred.

[b] EC = error correction; APT = antecedent prompt and test; APF = antecedent prompt and fade; MTL = most-to-least prompting; SLP = system of least prompts; CTD = constant time delay; PTD = progressive time delay; NT = Naturalistic Teaching; SF = stimulus fading; SS = stimulus shaping; IPS = integrated prompting systems (i.e., those combining and two or more strategies).

A summary of the results from comparative investigations is as follows: Procedures using antecedent prompting appear to produce fewer errors than error correction procedures (Haught, Walls, & Crist, 1984; Walls, Zane, & Thvedt, 1980). Strategies using stimulus shaping and fading had less errors than a most-to-least procedure (Schreibman, 1975), system of least prompts (Mosk & Bucher, 1984), time delay (McGee & McCoy, 1981), error correction (McGee & McCoy, 1981), or an antecedent prompt and fade procedure (Richmond & Bell, 1983). Mixed results exist for effectiveness and efficiency when the system of least prompts is compared to the most-to-least prompting procedure (Csapo, 1981; Glendenning, Adams, & Sternberg, 1983). The system of least prompts appears more effective than error correction (Rynders, Behlen, & Horrobin, 1979). Progressive delay was more efficient than system of least prompts in terms of number of sessions, errors, trials, and training time to criterion (Bennett, Gast, Wolery, & Schuster, 1986; Godby, Gast, & Wolery, in press). Progressive and constant time delay appear to be equally effective and efficient; however, with some students efficiency differences exist, but no predictor variables could be identified to determine which of the two delay procedures would be more efficient with which students (Ault, 1985; Precious, 1985). In some cases, incidental teaching appears to be more effective than error correction (Neef, Walters, & Egel, 1984). Integrated strategies appeared to be more effective than strategies used alone (Mosk & Bucher, 1984).

Because of the questions and subjects involved in comparative investigations, special experimental designs are required. Traditional group comparison designs were used in some of the comparative investigations, but require that the subjects assigned to each compared condition must be equivalent. If this requirement is not met, the threat of subject selection may be present and is likely to influence the results. When using subjects with moderate to profound retardation, autism, and multiple handicaps, establishing equivalence of groups requires a large population and may be difficult to document. As a result, many investigators have chosen to use single subject designs such as the multi-treatment (Birnbrauer, Peterson, & Solnick, 1974), parallel treatments (Gast & Wolery, 1985), alternating treatments (Barlow & Hayes, 1979), adapted alternating treatments (Sindelar, Rosenberg, & Wilson, 1985), or simultaneous treatments designs (Browning, 1967). Regardless of the design used, the investigator must control for sequence or order effects and multi-treatment interference (Tawney & Gast, 1984). Further, depending upon the research question, the investigator may wish to determine which strategy will result in criterion level performance and which strategy will be more efficient in establishing such performance (Wolery & Gast, 1986). In either case, the investigator must be able to document the effects of each treatment on independent responses that are of equal response difficulty.

8. Some methodological inadequacies were found in the literature. Although the purpose of this literature review was not to analyze the methodological adequacy of the investigations, several comments are pertinent. Some of the inadequacies can be remedied by more consistent reporting when writing articles for publication. Two areas deserve particular comment. First, the instructional strategies should be more consistently named. As noted in nearly every section, procedures that involved the same operational description were given different labels by different investigators. The system of least prompts strategy had the most names, but this may be due to

the fact that it also was the most frequently studied. Naming procedures consistently within the literature will help clarify and focus knowledge about a given strategy. Second, the operational descriptions of the strategies should be written more completely and clearly. In some cases, important information was not presented (e.g., how prompts were faded in the antecedent prompt and fade procedure, the response interval between prompts in the system of least prompts, and the criterion for moving from one delay interval to another in the time delay studies). In other cases, information was presented, but repeated readings by multiple readers could not produce a reliable interpretation of the text. Authors, as well as editors, should be more careful in ensuring that the final description of the study communicates the events that actually occurred.

Other methodological inadequacies may require changes in investigators' behaviors. While most studies provided reliablity estimates of the consistency with which student performance was measured, very few investigations included procedural reliability estimates (cf. Billingsley, White, & Munson, 1980; Peterson, Homer, & Wonderlich, 1982). As noted earlier, variations in the manner in which the strategies are implemented can influence their effectiveness. Thus, investigators should be careful to document the extent and manner in which the strategies were implemented. At a minimum, procedural reliability should be collected in every experimental condition/phase, but it is desirable to collect it on at least 20 percent of the experimental sessions. The procedures for conducting such measures were adequately described by Billingsley et al. (1980), and require no more investigator time or measurement expertise than collecting dependent measure reliablity estimates. In addition to reporting procedural reliability, investigators should assess and describe subjects' entry level skills. Such assessment and description is needed because (a) subjects' history and entry level skills can be used to explain the results, and (b) knowledge of the functional relationships existing prior to the study is needed for generalizing to other students (Birnbrauer, 1981). Examples of needed information are subjects' sensory abilities, compliance with task relevant commands, imitative abilities, expressive and receptive language performance on tasks similar to those in the investigation, matching abilities, response to tactile stimuli when physical prompts are used, reinforcer preferences, and their history with the procedure(s) being studied or compared.

Issues for Future Research

Although some areas for future research have been noted above and in other sections of this document, several issues are included here to highlight their importance. First, the instructional strategies should be investigated with preschool and early elementary students who have moderate to profound retardation, autism, and multiple handicaps. Second, more research should be conducted with chained responses. Chained responses are frequently those needed by students to function independently, but the current knowledge base related to teaching such skills is more limited than the knowledge base related to teaching discrete responses. Third, investigations which document failures should be reported. These investigations should include (a) careful documentation of subjects' entry level functioning, (b) careful description and documentation of the procedures used and of the modifications made, and (c) clear description of the behaviors being taught. Further, investigators should be encouraged by editors to report findings where a strategy was successful with some subjects but not with others. Fourth, more investigations that report on replications of the strategies with other subjects and populations should be conducted. Fifth, a series of studies that examine systematic variations of the procedural parameters of each strategy is needed. Sixth, more investigations that compare two or more strategies should be conducted. As noted in Table 1, at least 25 direct comparisons are possible but have not been conducted and described. Seventh, more integrated strategies should be investigated. Integrated strategies as defined by Schoen (1986) are combinations of two or more instructional strategies into a single procedure. In some cases (e.g., Mosk & Bucher, 1984), integrated strategies have been more effective than the strategies alone. Given this finding, integrated strategies deserve much more research attention. Eighth, the efficiency of the procedures should be assessed in all investigations that evaluate procedural variations of the instructional strategies, compare two or more strategies, or investigate integrated strategies. Examples of efficiency measures include sessions, trials, errors, and direct instructional time to criterion by procedure, and correct and error responses by prompt levels by procedure. Learning to learn phenomenon and other efficiency indicators such as incidental learning should also be investigated. Based on these suggestions, it is apparent that considerable research is needed before our knowledge of instructional strategies is complete.

Issues For Consideration when Selecting Instructional Strategies

A considerable amount of literature has accumulated concerning the selection of strategies for reducing the occurrence of inappropriate behaviors (cf. Bailey, Wolery, & Sugai, in press; Barton, Brulle,, & Repp, 1983;

Donnellan, Mirenda, Mesaros, & Fassbender, 1984; Evans & Meyer, 1985; Favell et al., 1982; Gast & Wolery, 1987); however, selection of instructional strategies is frequently left to the preference of the trainer. As a result, this section attempts to list some general guidelines by which instructional strategies should be selected. The purpose of listing these guidelines is to (a) cause more reasoned selection of instructional strategies, and (b) stimulate discussion of the reasons why a given strategy should be considered. Each guideline addresses the selection issue from a slightly different perspective; thus, each is important. The relative value of each will undoubtedly vary from student to student, skill being taught, and the preferences and biases of the team selecting the strategy. As a result, the order in which the guidelines are listed is arbitrary.

Empirical Data Base

Teams should select strategies based on the existing empirical data base. Teams should determine whether research reports exist documenting the effectiveness and efficiency of the strategies under consideration. This analysis should be two-fold. First, it should determine whether (a) the skill targeted for instruction has been taught using the instructional strategies under consideration, (b) the subjects who will receive instruction have been taught with the strategies under consideration, and (c) the settings in which instruction will occur has been used in previous research. If no reports exist describing successful use of the strategies with behaviors, subjects, or settings similar to those targeted for instruction, then the team should use other selection criteria, and investigate and describe the effects of the strategy selected for instruction. If, on the other hand, several strategies have been successful in teaching students to perform the targeted behaviors in similar settings, then the team should consider direct comparisons of the strategies.

Second, the literature should be reviewed to determine whether the instructional strategies under consideration have been compared with similar responses, subjects, and settings. If comparison studies exist, then ineffective strategies should be excluded from consideration. If both (all) procedures were effective, then the efficiency of the strategies should be analyzed, and the inefficient strategies excluded from consideration. When no comparison studies exist and when only efficient strategies are identified, then other selection variables should be considered.

Harmfulness of Procedures

The principles of *primum non noscere* (first not to injure) (Zigler & Sietz, 1975, p. 490) and the least dangerous assumption (Donnellan, 1984) should be considered. While most of the instructional strategies described in this report are relatively harmless, some involve physical contact with students that could set the stage for injury if inappropriate application occurred. When two or more strategies are equally effective and efficient based on their scientific data base, or if the scientific data base is lacking, then selection of strategies based on their potential for causing injury and harm is appropriate.

Intrusiveness and Restrictiveness

Teams should consider the intrusiveness and restrictiveness of procedures. Intrusiveness and restrictiveness are closely related issues: intrusiveness refers to the extent to which the instructional strategy intrudes or impinges on a student's being; whereas restrictiveness refers to the extent to which students' freedoms are constrained. In some cases, a prompt is both intrusive and restrictive; for example, a full physical manipulation is intrusive because it involves an intrusion on to the student's body, and is restrictive because the student's freedom to move is constricted. Some instructional variables may be intrusive but not restrictive; for example, an error consequence such as a verbal reprimand may be intrusive but does not restrict a student's freedom. On the other hand, a 15-sec timeout contingent upon errors may be more restrictive than intrusive; the timeout restricts the students' access to reinforcing events but does not intrude on their body or personal well being. Strategies that are not intrusive and are not restrictive tend to be more "natural," that is, similiar to stimulus events in the environments to which generalization of the acquired behaviors are targeted. Since training natural behaviors in natural contexts is thought to facilitate generalization, instructional strategies that are less intrusive and less restrictive should be used. However, when strategies are evaluated and selected on the basis of intrusiveness and restrictiveness, they should be simultaneously evaluated on the basis of effectiveness. Ineffective instructional strategies should not be selected simply because they are not intrusive, are not restrictive, and appear "natural."

Response Patterns

When selecting instructional strategies, teams should consider students' response patterns. Response patterns include such variables as reinforcement history, attention to instructional stimuli, history with similar instructional content, and history with similar instructional formats. For example, if physical contact with the teacher is a strong positive reinforcer, then instructional strategies that involve physical prompts may be less successful than those that do not rely on physical prompts. If students respond quickly to task directions without attending to the instructional stimuli or waiting for teacher assistance, then (a) procedures that delay assistance may be contra-indicated, (b) an attention response should be required, or (c) waiting for assistance should be taught. If students have a history of learning particular types of responses with a given procedure, then use of similar procedures may be indicated. Students with a history of one-on-one instruction may need specific instruction in group formats before a new instructional strategy in group formats should be used. If students have generalized imitative repertoires, then strategies that use models should be considered; if they do not, then those strategies should not be selected.

Phase of Performance

Instructional strategies should be selected that match the phase of learning evidenced by the student (Haring, Liberty, & White, 1980; Wolery & Brookfield-Norman, in press). Haring et al. (1980) have suggested that (a) different phases of learning exist (i.e., acquisition, fluency, maintenance, generalization, and adaption), and (b) each phase may require unique instructional manipulations. In general, acquisition is promoted by procedures that provide antecedent information to students. This review focused on strategies used to establish acquisition of targeted responses; however, teams must select strategies that focus on the other phases as well. Fluency appears to be established by procedures that manipulate consequences and increase practice time. Maintenance appears to be promoted by thinning reinforcement schedules, delay reinforcers, using natural reinforcers, and duplicating natural reinforcement schedules. Generalization appears to be facilitated by careful selection of teaching examples; varying examples, teachers, teaching formats, instructional materials, and instructional settings; and matching the instructional environment to the generalization environment. When the phase of learning is identified for a student, then the instructional strategy that best matches that phase should be selected. The instructional strategies reviewed in this document can be used for establishing acquisition, and then components of those strategies can be manipulated to facilitate fluency, maintenance, and generalization.

Principle of Parsimony

When all other factors are equal, teams should select procedures on the basis of parsimony (Etzel & LeBlanc, 1979). The principle of parsimony states that when two solutions are correct, then the simpler solution should be employed. Two advantages accrue from the use of simpler strategies: (a) fewer procedural errors are likely to occur, and (b) teachers must expend less effort. The chapters describing strategies in this document are roughly listed in order from the most to the least parsimonious. As with intrusiveness and restrictiveness, the principle of parsimony should apply only to those strategies that are effective; strategies should not be used only because they are simple.

Social Validity

Social validity refers to the worth assigned by experts and consumers to the educational goals, procedures, and outcomes of an educational endeavor (Wolf, 1978). P.L. 94-142, through the IEP process, requires that instructional goals and procedures be selected and used based on their social validity. That is, the team, including the parents, should determine whether the instructional objectives are worthwhile and whether the methods used to establish them are appropriate. Social validity involves judgments by different parties, thus, there may be some disagreement among team members about the social validity of given strategies. However, for intervention strategies designed to reduce the occurrence of inappropriate behaviors, it is clear that more intrusive and restrictive procedures are judged as socially valid if the behavior to be controlled is severe, and that judgements about the social validity of procedures is malable. Thus, no procedure is inherently socially valid, rather procedures appear to be judged valid for specific situations and those judgments can be changed if more information is provided about previous success and likely outcomes.

Summary

The literature reviewed in this document can be summarized by eight statements:

(a) considerable evidence exists suggesting that the instructional strategies are effective across a wide array of behaviors and subjects;

(b) relatively few replication and parametric studies of the instructional strategies exist;

(c) secondary aged students and adults were used in most of the investigations;

(d) most studies occurred in public school and institutional setings;

(e) chained tasks were taught much less frequently than discrete responses;

(f) most of the behaviors taught were socially valid,

(g) relatively few studies comparing the instructional strategies have occurred, and

(h) the research has certain methodological weaknesses that should be addressed.

More research is needed that includes younger subjects and chained responses. Also, reports of failures of the strategies should be reported. More replication studies, comparative studies, integrated strategy studies, and efficiency studies should be conducted. Finally, instructional strategies should be selected based on their empirical data base, potential harmfulness, intrusiveness and restrictiveness, correlation with students' response patterns, match to students' phase of performance, parsimony, and social validity.

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CODES FOR RESULT TABLES APPENDIX A

Population								
Number/ Gender	Age/ Yrs.	Diagnosis	Setting	Effectiveness	Efficiency	Generalization	Maintenance	Design
arabic numerals = number of subjects	(#-#) = range (x = #) = mean N/D = not defined	N/D = not defined N = normal LD = learning disabled EC = economically disadvantaged SCH = schizophrenic SLI = speech language impaired SBD = severe behavior disordered ED = emotionally disturbed BMR = borderline mental retardation DD = developmentally delayed/disabled HI = hearing impaired VI = visually impaired Aut = autistic MH = multiply handicapped MiMR = mild mental retardation MoMR= moderate mental retardation SMR = severe mental retardation PMR = profound mental retardation	IN = institution or residential PS = public schools CS = community settings SS = special schools	+ = total effectiveness +/- = effective with some subjects, but not others: definite change in behavior, but not to criterion levels - = not effective +m = effective with modifications of the procedure N/A = not applicable >/< = parametric studies arabic numeral = number of subjects	S = session or days to criterion T = trials to criterion E = errors to criterion M = minutes (hours) to criterion N/D = not defined >/< = parametric studies P/U = prompt level use A = anecdotal arabic numberal = number of subjects	+=occurred 80% and above -=did not occur +/-=gen. with some subjects and not others P=people/ trainers S=settings T=task/ behavior/ stimuli m=modification of training procedure A=anectdotal N/D=not defined	D=days W=weeks M=months +(time unit)= maintenance occurred -(time unit)= maintenance did not occur +/-(time unit)= maintained with some subjects but not others A=anecdotal m=modification of training procedure N/D=not defined	A-B= simple baseline treatment GR=group MB=multiple baseline MP=multiple probe AT= alternating treatments WTD= withdrawl REV= reversal TT= teach/ test PP=pre/ post CC=changing criterion PT= parallel treatment ST= simultaneous treatment RM= repeated measures N/D=not defined